AGRICULTURAL ENGINEERING

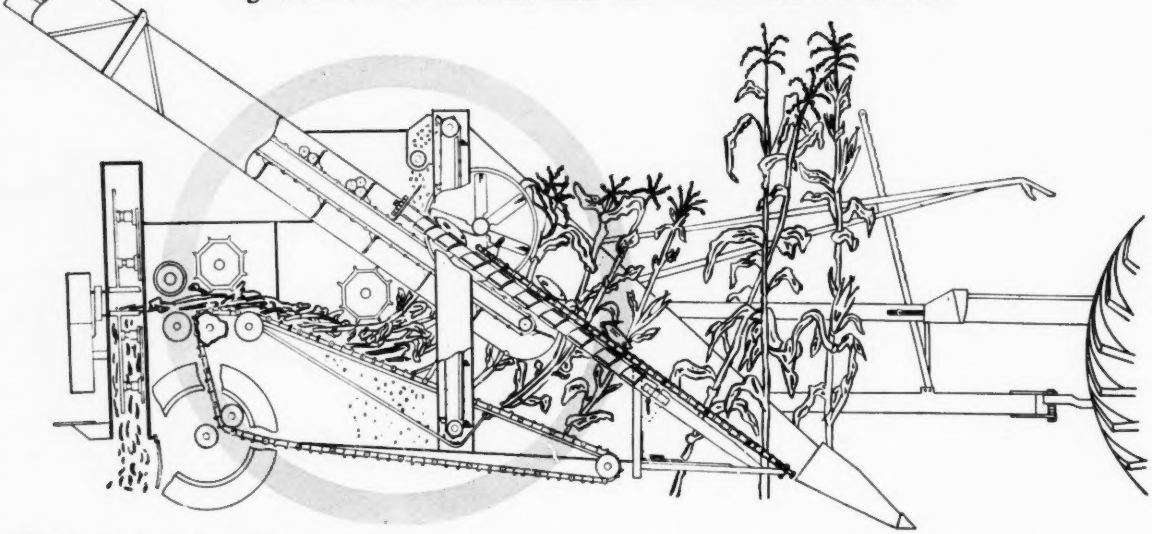
AUGUST • 1954

In this Issue . . .

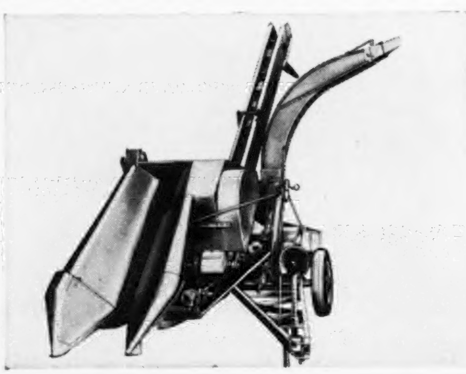
THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Saves THE LOST BUSHELS

Only that part of the corn crop that's either sold or fed puts money in the farmer's pockets. But what of those bushels and tonnage that never leave the field . . . the kernels that shell and drop to the ground . . . the leaves and stalks that could make dry roughage, low-cost silage . . . excellent bedding? Salvage of this part ordinarily lost would be a big windfall . . . additional use and extra income from the whole corn crop . . . besides the value of the shelled kernels saved.



That's why Case dug deep to serve, to give farmers a way of full use of their corn crop. Via the routes of research and design, Case engineers have developed a machine that saves bushels per acre, the loss usually incurred by mechanical picking. Kernels ordinarily lost going through picking rolls drop to a floor underneath the stalkway. A chain rake, in turn, delivers them to the elevator where they join the ears on the way to the wagon. The drawing above and the photo to the left show this new, shielded feature.



There's an equally great crop-salvage feature, one that provides a new kind of bonus to cost-conscious farmers. In the same operation of picking, the Case Corn Harvester chops or shreds stalks and leaves. In terms of crop savings, it takes tough vegetation . . . cuts it into desired lengths and blows it into a forage wagon for low-cost, filling feed or absorbent bedding. For those who prefer, it chops or shreds stalks into fine material . . . returns it direct to the ground for rapid decay, also making plowing and disking much easier and faster. At left is the Corn Harvester equipped to deliver chopped stover into trucks or wagons. J. I. Case Co., Racine, Wis.

CASE

AGRICULTURAL ENGINEERING

Established 1920

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RAYMOND OLNEY
Editor and Publisher

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DRIVER RAYMOND LITTLE of Vigo Cooperative Milk Marketing Co., Inc., takes a butterfat sample from the Stainless Steel tank of one of the association's producers.

DRIVER LITTLE UNLOADS milk picked up on his route from the 2000-gallon Stainless Steel tanker at a milk manufacturing plant in Terre Haute.

Bulk milk handling system with Stainless Steel farm tanks reduces marketing costs for Indiana cooperative

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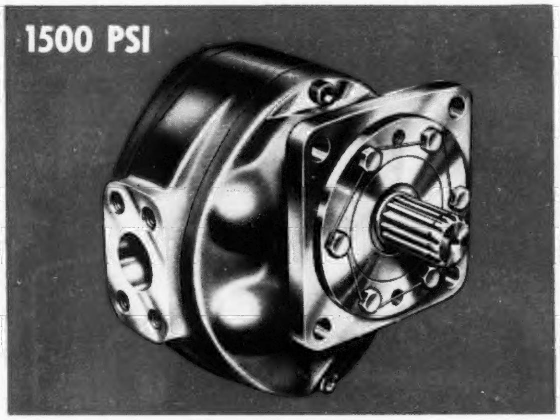

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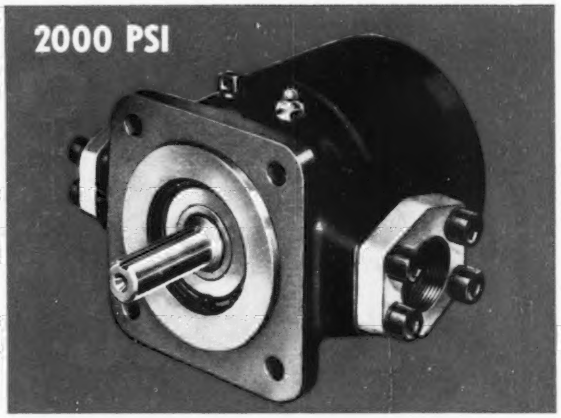

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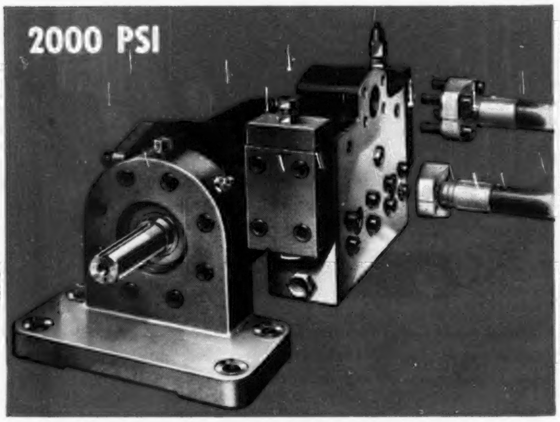

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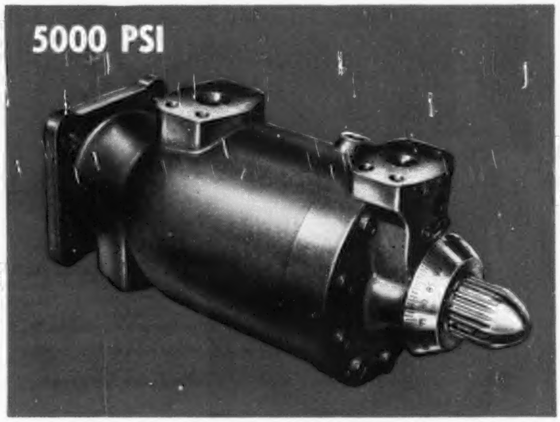

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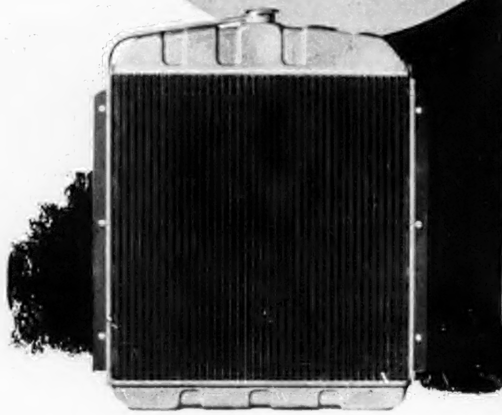

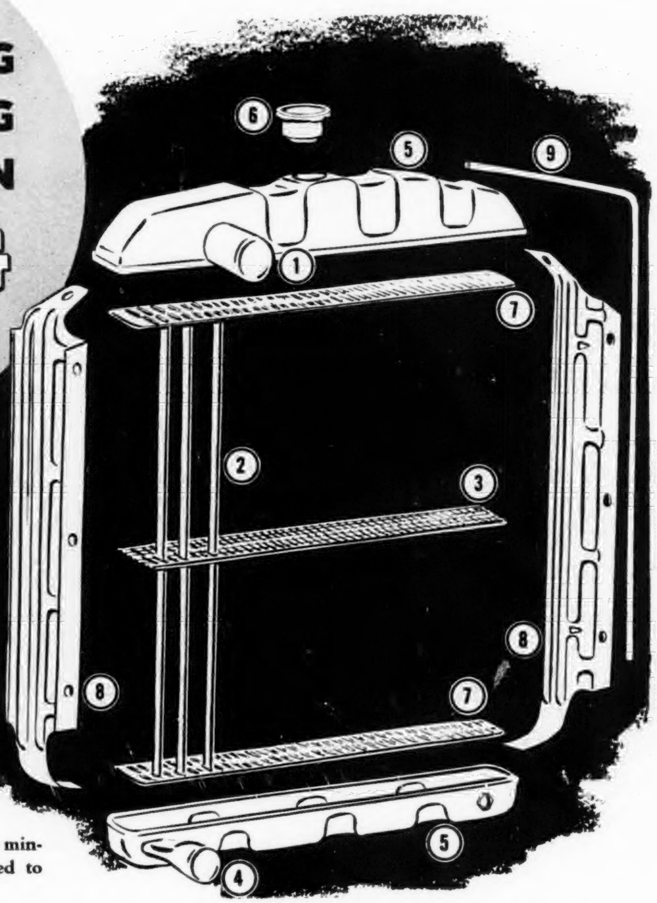

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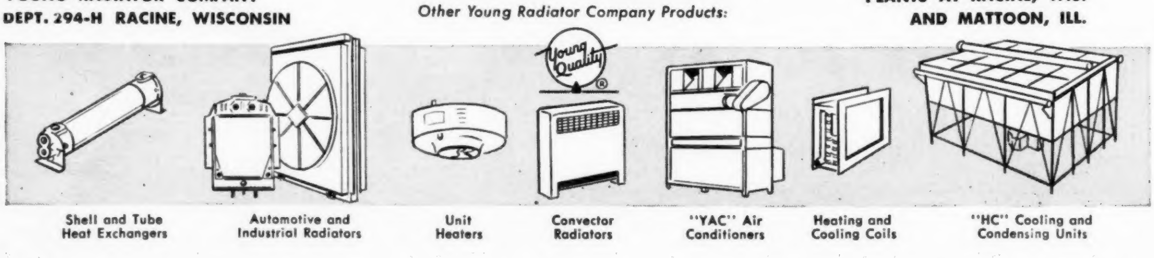

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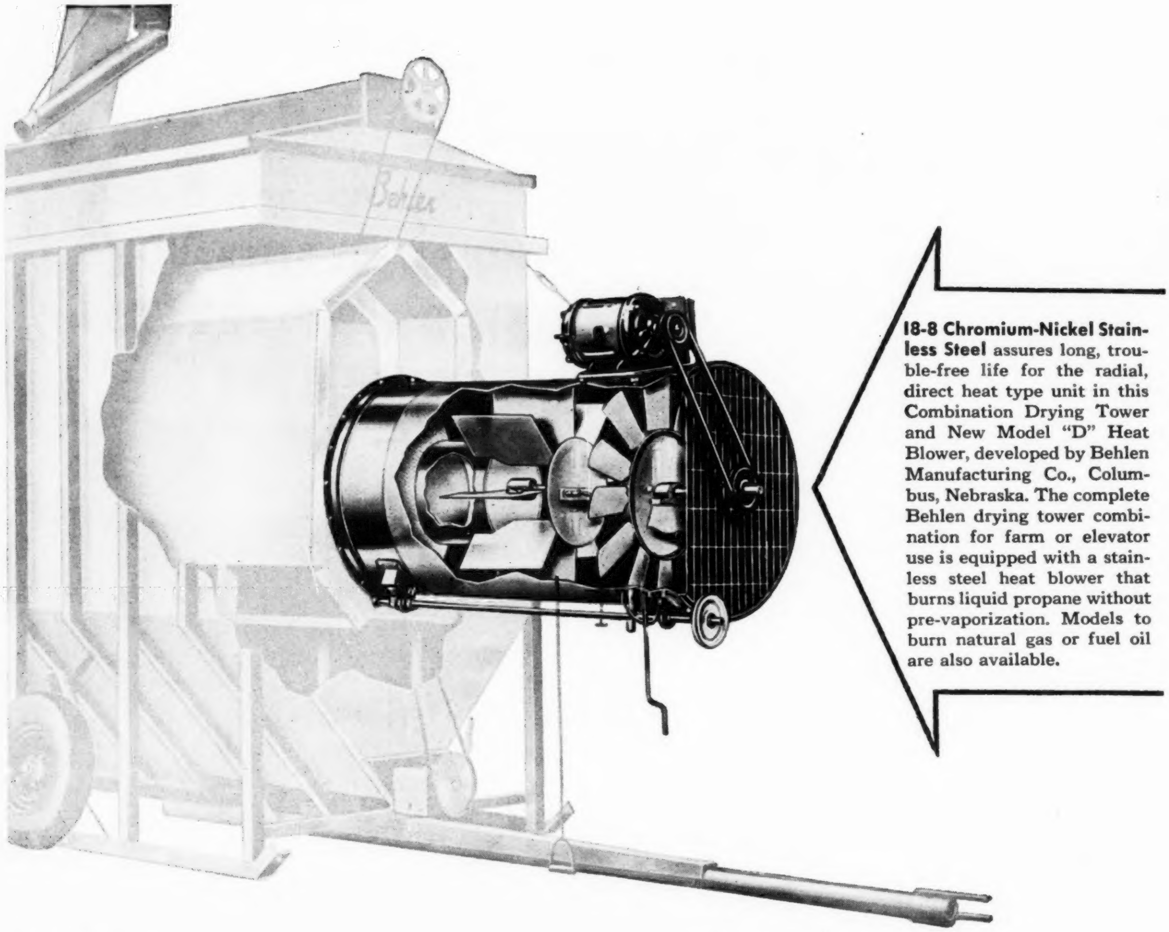

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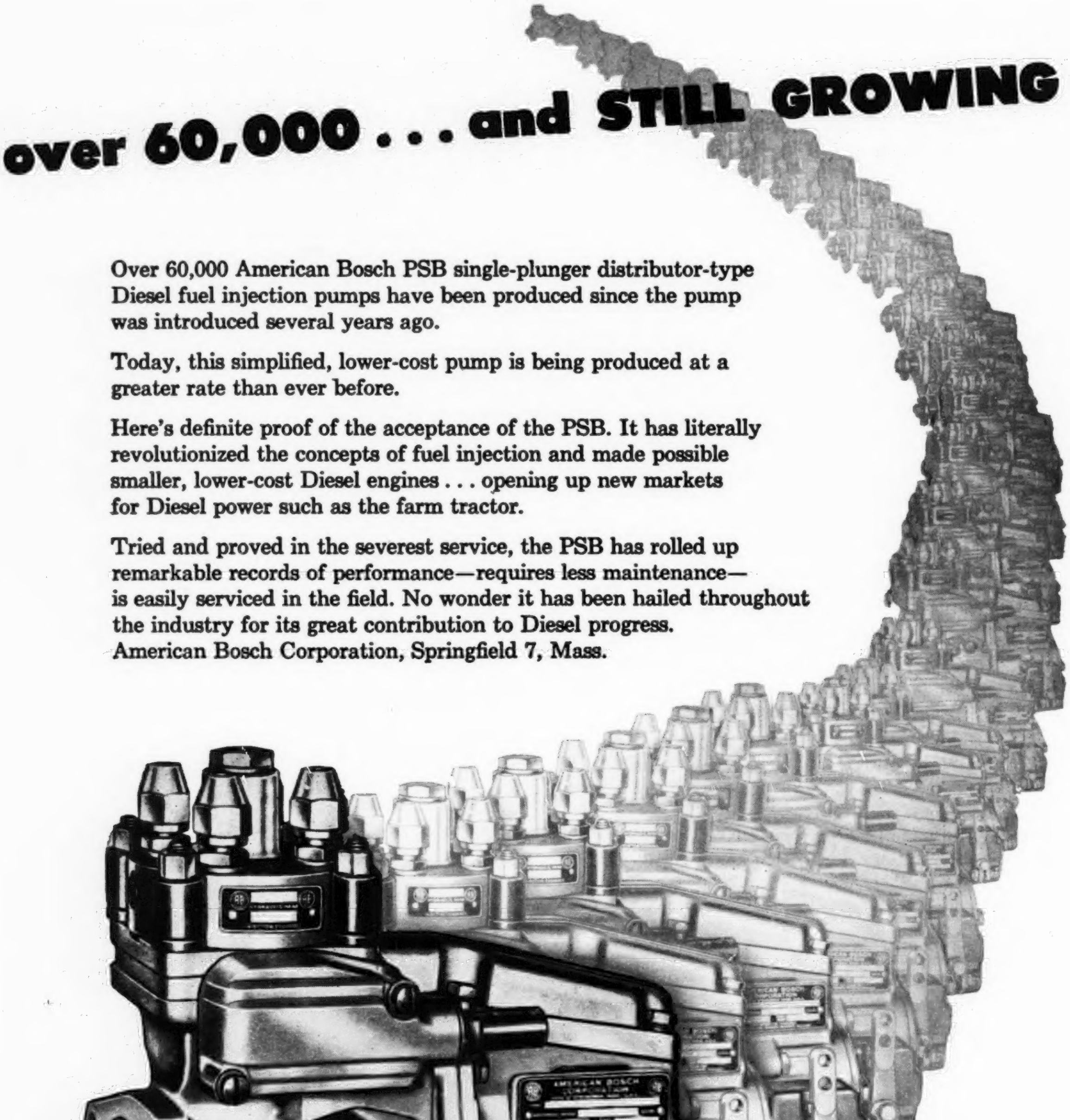

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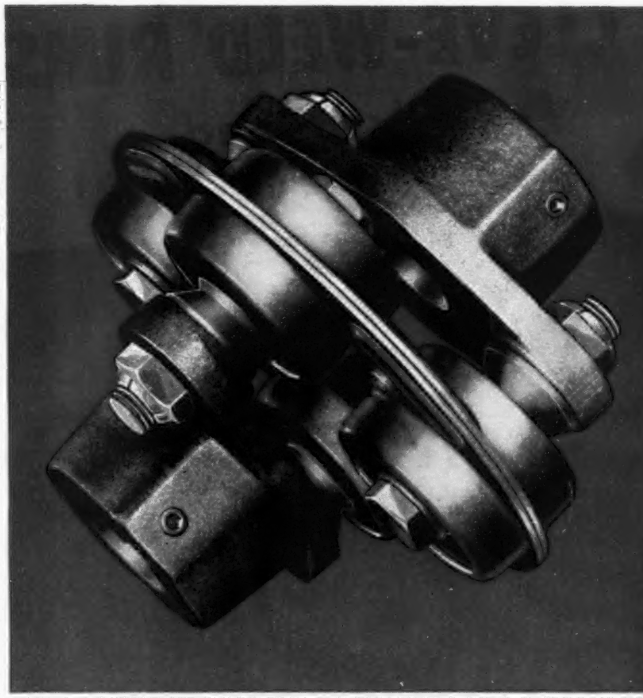

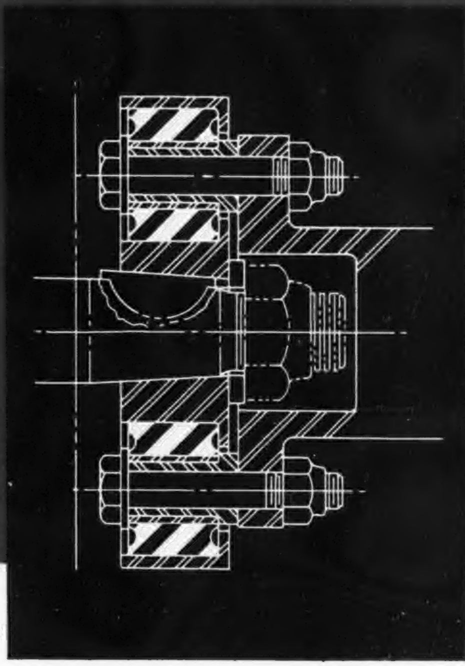

Above: Standard Morflex Flexible Coupling. Special adaptation of Morflex principle is shown at right.

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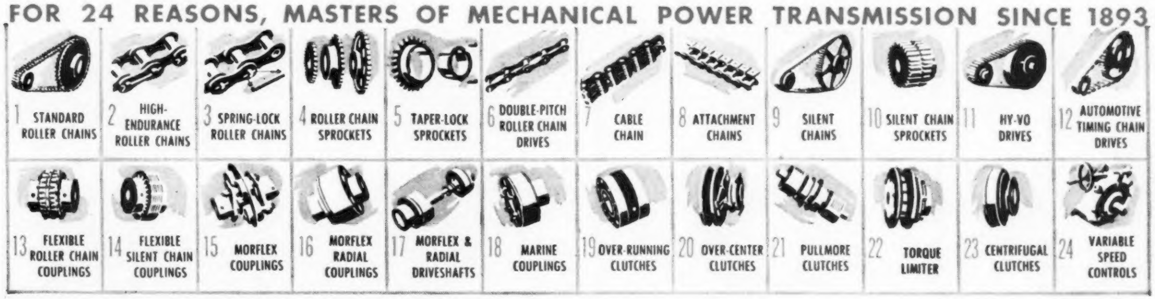

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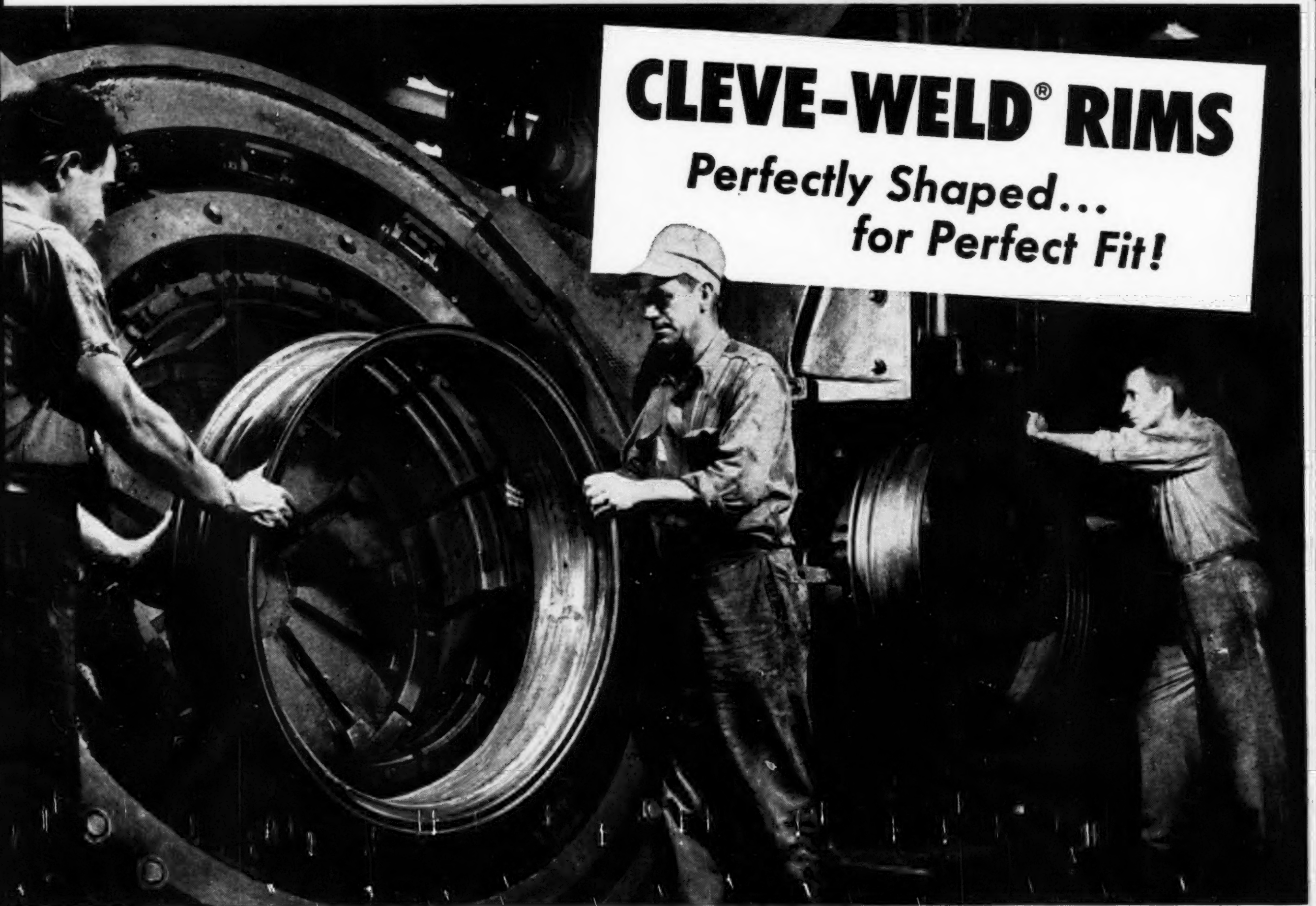

EVERY CLEVE-WELD RIM, during its manufacture, is forcibly expanded and then compressed under tremendous hydraulic pressure to its final size and shape. This not only produces a rim of accurate dimensions and true circular shape but also proves the strength of the weld.

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Massey-Harris Model 44 Tractor features Hyatt Barrel Bearings. One of the tough jobs in the tractor—the spindle shaft where bearings really have to stand the gaff—is entrusted to HYATT Barrel Bearings. Result: *less* wear, *less* maintenance, far *more* customer satisfaction!

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AGRICULTURAL ENGINEERING

VOL. 35 AUGUST, 1954 NO. 8

Self-Feeding of Chopped Hay

Kenneth K. Barnes and Hobart Beresford
Member ASAE Fellow ASAE

Agricultural Engineers Develop Experimental Self-Feeder That Is Positive in Operation

FIELD operations in hay harvest have been brought to complete mechanization by the field chopper, the self-unloading wagon, and the forage blower. Using these methods chopped hay can be harvested and placed in storage with a labor requirement of 1.0 to 1.5 man-hours per ton*. A similar degree of mechanization or reduction in labor requirement has not been generally achieved in removing chopped hay from storage and placing it before livestock.

The right-vertical cylinder has a natural appeal as the form of a storage structure. A maximum of capacity may be obtained in a shell of minimum area, and load-bearing elements are in tension (circumferential elements) or in column action (vertical elements) rather than in bending. The cylinder offers advantages in drying, in that uniform radial flow of drying air may be obtained with a minimum of duct work.

A basic failing of the cylindrical structure is, however, shown in Fig. 1. Cattle are unable to reach hay located near the center of the structure. This hay forms a column which is capable of supporting the entire mass of hay above.

Another factor which may potentially retard self-feeding is friction of the internal duct and the outer shell against the hay. These problems were observed in a commercial self-feeder which was erected on the Iowa State College Dairy Farm in 1949. From these observations certain functional criteria were developed which were aimed at eliminating the several causes of failure to self-feed.

The design which was evolved *(a)* eliminated the central duct structure, providing an unlined opening in its place, *(b)* provided a cone in the base of the structure to cause hay to flow out to within reach of the cattle, *(c)* provided cleavage planes in the hay to allow it to flow over the cone, *(d)* included a taper from bottom to top of the structure to relieve sidewall pressure, and *(e)* utilized a swinging manger guard which enabled cattle to reach well into the structure. Several of these features may be seen in Fig. 2.

The central-duct structure was eliminated by pulling a cylindrical plug up through the center of the structure as the hay is blow in. The dimensions of this plug have been 3 ft in diameter and 5 ft long in a 15-ft diam structure and 5 ft in diameter and 8 ft long in a 23-ft-diam structure. The opening left by this cylinder serves as a duct for the passage of drying air. Dimensions of the cylinder are based on air-flow fundamentals. Fig. 3 shows the relative static pressure requirement to move a given flow of air through an annular hay mass as a function of the ratio of internal to external diameter of the hay mass. Also shown is the relationship between hay storage volume and duct diameter. The pressure curve was calculated by application of the relationship

$$V = cp^{0.722} \qquad [1]$$

where v = velocity of air through chopped hay in linear flow
p = pressure drop through the mass of hay
c = constant dependent upon the length of flow path and resistance of hay to air flow.

This equation was based upon experimental observations

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Rural Electric Division. Contributed as Journal Paper No. J-2561 of the Iowa Agricultural Experiment Station, Ames, Iowa, Project 1195.

The authors—KENNETH K. BARNES and HOBART BERESFORD—are, respectively, professor of agricultural engineering and professor and head of the agricultural engineering department, Iowa Agricultural Experiment Station.

Acknowledgment: The authors gratefully acknowledge the assistance and advise of R. E. Armstrong, E. V. Collins, G. C. Shove, and R. R. Yoerger.

*Barger, E. L. Mechanization of haymaking and storage. In: Forages, Hughes, H. D., et al, eds. The Iowa State College Press, Ames, Iowa, 1951.

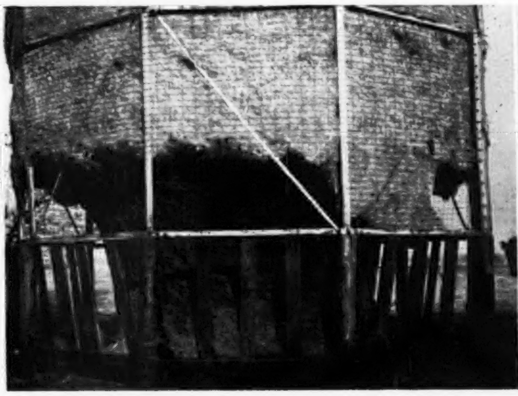


Fig. 1 *(Extreme left)* Cylindrical hay self-feeder showing how a column of hay beyond reach of the cattle prevents the hay mass from feeding down • Fig. 2 *(Left)* Cylindrical self-feeder incorporating *(a)* duct-forming cylinder with motor and fan, *(b)* fins for forming radial, vertical cleavage planes, (c) cone in base of structure, and *(d)* swinging manger guard

and has been presented by Ball†. The relationship between velocity and pressure expressed by equation [1] may also be expressed as

$$p/L=(v/k)^{1.386} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

where L = length of flow path

k = constant dependent upon the resistance of hay to air flow.

In developing the pressure curve of Fig. 3, equation [2] was applied to a series of annular rings of hay, assuming the mean circumferential area of the ring as the area of an equivalent section of linear flow. Because of this process of numerical approximation and because the exponent, 1.386, may be a function of hay density, length of cut, and air velocity, the curve is only qualitatively significant.

From Fig. 3 it may be seen that a duct diameter of 0.20 to 0.25 the outside diameter results in a relatively low static-pressure requirement yet maintains a relatively high storage volume. The diameters of the duct-forming cylinders used in the structures discussed here have fallen within the range of $0.20 \leqq d/D \leqq 0.25$. The length of the duct-forming cylinder is governed by the value of the outside diameter of the structure, D, and the duct cylinder diameter, d. It is felt that the length of the duct-forming cylinder should not be less than $\frac{3}{8}$ $(D-d)$. At the end of a day's filling of the hay storage, the hay is brought up to the level of the top of the cylinder and drying started. A cylinder length of $\frac{3}{8}$ $(D-d)$ will prevent excessive air flow up past the plug which would result with a flow path greatly shorter than the thickness of the annular hay mass. Thus air-flow paths and static-pressure requirements limit minimum dimensions of the duct-forming cylinder. Maximum cylinder dimensions are limited by the criterion of bulk in relation to handling.

The cone in the base of the structure is at 45 deg and has a slotted surface to allow passage of drying air into the adjacent hay. The base of the cone extends to within 30 in of the inside of the manger. A steeper cone or a cone with a concave surface may be desirable. Experience of the authors

†Ball, C. E. Artificial drying of chopped hay. Unpublished M.S. thesis. Iowa State College, 1948.

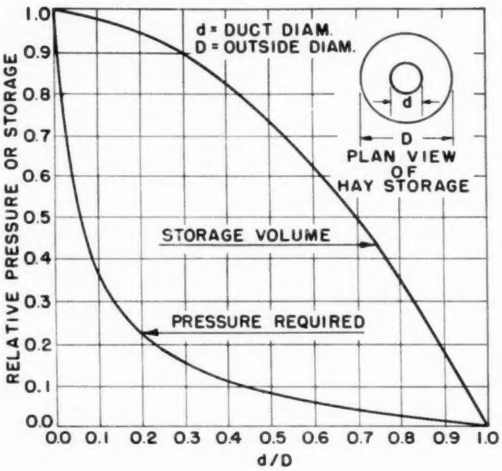


Fig. 3 Relative pressure requirement for a given air flow, and relative storage volume for a given outside diameter, as functions of the ratio of duct diameter to outside diameter of a cylindrical hay self-feeder

and of others has indicated that a cone alone is not sufficient to cause hay to separate and move into the manger. In passing down a conical surface an annular ring of hay must increase in circumference. Due to the interlocking of the short pieces of hay and the pressure of hay above, the hay mass has considerable tensile strength. This strength is often sufficient to prevent circumferential spreading of hay and consequently prevent movement over a cone. Vertical, radial cleavage planes formed in the hay allow it to spread circumferentially and flow over a cone. Fig. 4 shows how one of these cleavages has opened as hay has moved down over a cone. These cleavages are formed by radial panels attached to the duct-forming cylinder. Experience indicates that four of these panels are sufficient. The panels extend to within $2\frac{1}{2}$ ft of the outside of the structure. This allows cattle to feed into the cleavage plane areas, and yet tends to prevent piping of drying air out through the cleavages.

A slight taper in structure diameter acts to relieve sidewall resistance as the hay mass moves down. The importance of this feature has not been definitely established, and it is regarded mainly as insurance against

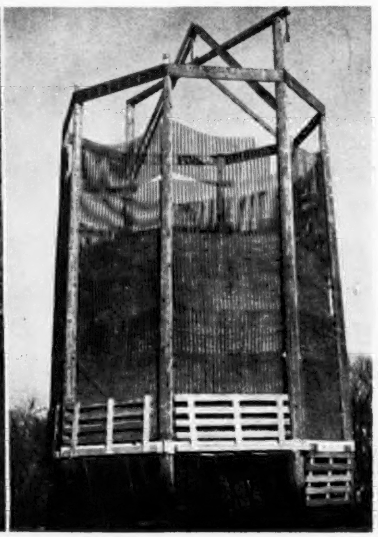


Fig. 4 *(Extreme left)* Radial cleavage which has opened as hay separates and moves to the manger in a cylindrical hay self-feeder which incorporated a base cone and a duct-forming cylinder with fins • Fig. 5 *(Left)* Cylindrical hay self-feeder made of poles and snow fence which incorporated the duct-forming cylinder with fins, base cone, swinging manger guard and taper from base to top. Hinged gates are to control the quantity of hay consumed

restrictions in diameter which might result from lack of precision in some types of construction.

The swinging manger guard prevents cattle from entering the structure, but enables them to reach well into the hay and to clean off the lower third of the cone. For beef cows the space between vertical bars has been 15 inches. These bars are hinged at the top, and secured at the bottom by a slack chain which is fastened to the manger at points around the base. Between bars the chains are slack enough to allow the bars to spread to about 20 inches.

These five design features have been incorporated into two hay storage structures. The structure shown in Fig. 2 was made from a woven-wire crib placed on top of fence posts. It was located at the Iowa State College Dairy Farm at Ames, Iowa. In this structure the drying fan was placed in the top of the duct-forming cylinder. The 36-in fan powered by a 5-hp motor exhausts air out the top of the cylinder. Thus the drying air travels from the outside through the hay to the central duct. This structure is 15 ft in diameter and 20 ft high.

The second application is shown in Fig. 5. This structure is located on the Iowa Agricultural Experiment Station's Ankeny Field Station at Ankeny, Iowa. The basic shell was constructed of 8 poles set on a 23-ft-diam circle. The structure is 30 ft high and the diameter at the top is 22 ft. Snow fence was added as the structure was filled with hay. In this structure the duct-forming cylinder had an airtight top and drying air was forced into the central duct through a removable lateral duct at the base of the structure. Thus drying air passes from the duct out through the hay to the outside.

The exhaust system and the forced-air system of drying each have advantages. The exhaust system eliminates the need for a lateral air duct. However, at the completion of drying the fan and motor are at the top of the structure where it is difficult to make them available for other uses.

The forced-air system dries the outside hay, which is readily examined by the operator, last. This tends to assure that the fan will be operated for a sufficiently long period of time.

Hay for these structures has been field chopped to medium length at a nominal moisture content of 35 percent. Hay is blown into the structure and uniformly distributed around the duct-forming cylinder. The drying fan is started as soon as the base cone and about half of the cylinder have been submerged. It is felt that, as filling continues, the additional pressure of the partially dried hay in the lower part of the structure restricts air flow through this portion and causes more of the air to pass through the higher moisture hay above. Hay is dried from 35 percent moisture to about 15 percent moisture with about 10 days of fan operation. Fans used have produced air flows of about 500 cfm per ton of capacity of the hay storage.

In the wire crib hay storage, inadequate drying of the hay due to management failure resulted in a failure to self-feed from the 1953 filling. The pole-and-snow-fence structure, however, has performed well. One source of trouble resulted from failure to extend the cleavage planes below the upper tip of the cone. It was necessary to pull down hay by hand until sufficient downward movement of the hay mass had occurred to bring the cleavage planes within reach of the cattle. This served to demonstrate the importance of these cleavages to the action of the structure. For the remainder of the season complete self-feeding was achieved.

SUMMARY

Vertical, cylindrical hay self-feeders of conventional design have failed to function properly because of a supporting central column of hay beyond the reach of the cattle, and the resistance to hay movement by the central air duct and the outer walls of the structure. An experimental structure has been developed which eliminates these causes of failure to self-feed by providing *(a)* an unlined central opening for drying air, *(b)* a cone to force hay out to the cattle, *(c)* radial cleavages in the hay to enable it to spread over the cone, *(d)* a taper from bottom to top of the structure, and *(e)* a swinging manger guard which allows cattle to reach well into the structure. A structure incorporating these features has successfully self-fed during the 1953-54 season.

Motor Grader Cleans Weeds from Irrigation Ditches

A practical solution of the problem of weed growth on the banks of irrigation ditches has been found by the officials of the Lower Tule River Irrigation District at Porterville, Calif., in the equipment shown in these pictures. The versatility of the Caterpillar 112 motor grader, purchased originally for maintaining levee roads has been increased to solve the weed problems in the ditches themselves. The grader was adapted to slope banks and clean weeds from the inside slopes of the District's irrigation ditches by attaching a modified shoulder finisher to the moldboard of the grader. The 12-ft extension was built with a hinge connection to the regular blade and a turnbuckle adjustment was installed to regulate the tilt of the extension. A cable, controlled from the seat of the driver, was rigged through the scarifier power control to regulate the blade slope. The attachment was fabricated at a cost of about \$300. The motor grader now cleans and slopes ditches at an average rate of about one mile in 45 min on ditches having a capacity of 50 cfs. The District has about 80 miles of main ditch varying from 250 to 50 cfs, and approximately 30 miles of sublaterals.

Combine Harvesting of Small-Seed Legumes

Philip R. Bunnelle, Luther G. Jones, John R. Goss
Assoc. Member ASAE Assoc. Member ASAE

Results of a Field Study of Test Procedures to Determine Combine Performance

SMALL-SEEDED legumes are grown extensively in the interior valleys of California, where hot, dry summers favor high seed yields and easy harvest. Because of high cash returns, most seed growers plant their legumes specifically for seed production and follow cultural practices that will maximize seed yield. Production of hay by seed growers is only of secondary importance. It is not surprising, therefore, that California is a leading producer of certified alfalfa and Ladino clover seed.

In 1948, when approximately 10 percent of the California seed crop produced for certification failed to pass minimum germination requirements, staff members of the departments of agronomy and agricultural engineering at the University of California undertook to determine the causes. Other problems related to alfalfa seed harvesting were also studied. Preliminary investigations in 1949 indicated that proper adjustment and operation of harvesting equipment could increase the average germination of alfalfa seed by 10 percent and could reduce field losses considerably (1)*. These studies also indicated that the investigation of small-seeded legume harvesting problems should be continued and expanded. A joint project of the two departments set up for this purpose is still active.

Combine performance was determined by test procedures similar to those described by McCuen and Silver (2). In each test, the straw from the straw walkers, the chaff from the shoe, and the clean seed from the delivery spout were collected separately (and simultaneously), while the combine was traversing a measured distance (usually 25 to 50 ft). The time to traverse the measured distance was recorded by a stop watch and the swath width or distance between windrows was measured. In most cases, tests at three or more feed rates, covering a considerable range, were made for each set of combine adjustments. The change in feed rate was obtained primarily by varying the forward speed of the harvester.

The walker and shoe fractions were analyzed in the laboratory for free and unthreshed seed. A fanning mill was used to recover the free seed contained in each of these fractions. The unthreshed seed was then recovered separately by using a hammer mill to rethresh the seed and the fanning mill to recover it.

A sample of the seed collected from the grain spout during the test was examined in the laboratory for threshing damage. The percent of visible damage for the sample was determined by examining several groups of 100 seeds under a binocular microscope.

In all results reported in this paper, the load rates for the walkers and for the shoe are based upon the weights of straw and chaff collected from the respective locations at the rear of the machine. The *total* feed rate or load rate into the machine and through the cylinder is the sum of the walker and shoe load rates. Seed weights are not included in any of the load rates.

In some of the tests, the tailings were collected for a short period of time (10 to 15 sec) immediately after the regular run was completed, without stopping the machine. Most of these tests were made on a harvester equipped with a special gate (Fig. 1) at the discharge end of the return elevator, to allow the tailings to be easily and completely collected.

During three years (1951 through 1953), approximately 250 tests were made on 30 different combines and two stationary threshers harvesting a total of seven different crops—alfalfa, Ladino clover, red clover, alsike clover, Birdsfoot trefoil, barley, and Merion bluegrass. Since most of the small legume seed acreage in the state is harvested with 12

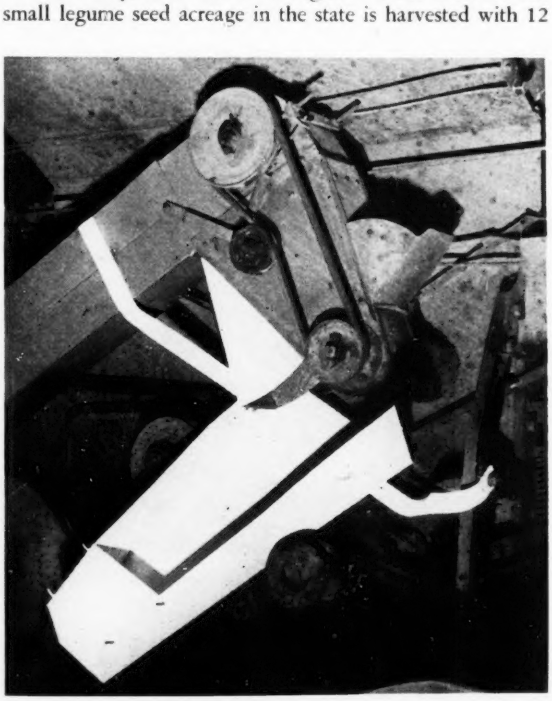


Fig. 1 Tailings collection gate for the return elevator. All of the tailings were diverted into the chute when the gate was open, but the return system functioned normally when the gate was closed

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Power and Machinery Division. A contribution from the Agricultural Experiment Station, University of California, Davis.

The authors—PHILIP R. BUNNELLE, LUTHER G. JONES, and JOHN R. GOSS — are, respectively, formerly assistant specialist in agricultural engineering, specialist in agronomy, and assistant specialist in agricultural engineering, University of California, Davis.

Acknowledgments: The authors acknowledge the considerable work done on this project by R. A. Kepner and Roy Bainer of the University of California (Davis) and by J. P. Fairbank of the University of California Extension Service. They wish to thank Bernell Harlan, Theo. Dumars, and many other farm operators who cooperated in this study. The authors also express their appreciation to Wayne H. Worthington of the John Deere Waterloo Tractor Works for his editorial help and to R. A. Kepner of the University of California for his comments on the preparation of the paper.

*Numbers in parentheses refer to the appended bibliography.

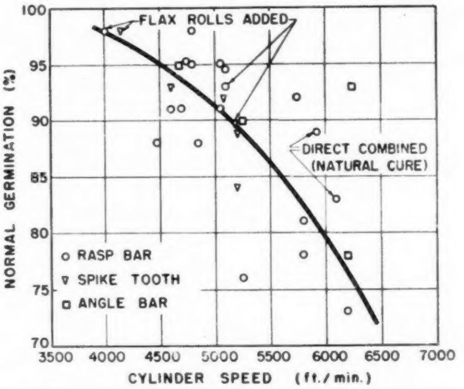


Fig. 2 Effect of peripheral cylinder speed on germination of alfalfa seed for various types of combines. Seed moisture content ranged from 5.2 to 7.5 percent. (Data from L. G. Jones, R. A. Kepner, Roy Bainer, and J. P. Fairbank. *California Agriculture*, August, 1950.)

to 16-ft, self-propelled combines, nearly all of the tests were made on these machines, and all data and curves presented in this paper, with the exception of Fig. 2, are for this type of harvester. Only limited work was done on the smaller combines and stationary threshers, but results indicate that the information applies generally to these machines as well.

Preparation of Crop for Harvest

The most common method of preparing the crop for harvest is windrowing, although in recent years spray-curing has gained rather wide acceptance (3). The spray causes desiccation of the plant, particularly the leaves, pods, and growing points. As soon as the moisture content of these parts drops to 15 to 20 percent, the crop is ready for harvest, even though the stems may still have a moisture content of 50 percent or more. When harvesting from the windrow, the average moisture content, including both leaves and stems, ranges from 12 to 18 percent.

Cutter-Bar Losses

In alfalfa, the cutter-bar losses are usually quite low when proper harvesting methods are used. Losses of 5 to

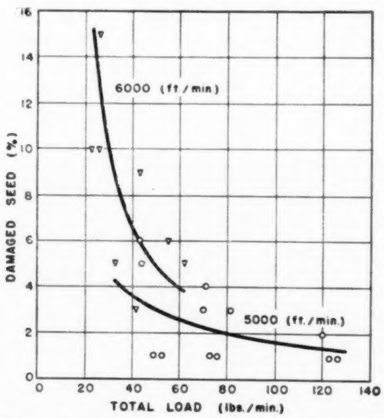


Fig. 3 Effect of harvester feed rate and cylinder speed on visible damage to Kenland red clover seed. Rasp-bar cylinder. Concave openings blanked off by securing sheet metal to the underside of the concave grate. Seed moisture content, 4.7 to 5.2 percent

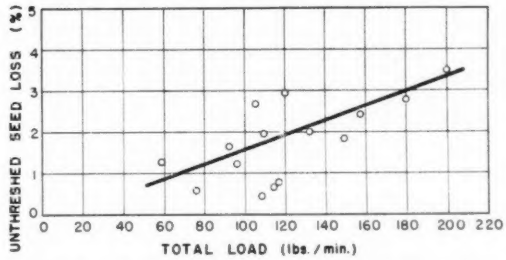


Fig. 4 Relation of harvester feed rate to loss of unthreshed alfalfa seed. Rasp-bar cylinder equipped with flax rolls. Cylinder speed, 4000 fpm. Cylinder clearance, 0.20 in. Concave blanked off. Air temperature, 80 to 100 F. Relative humidity, 17 to 40 percent

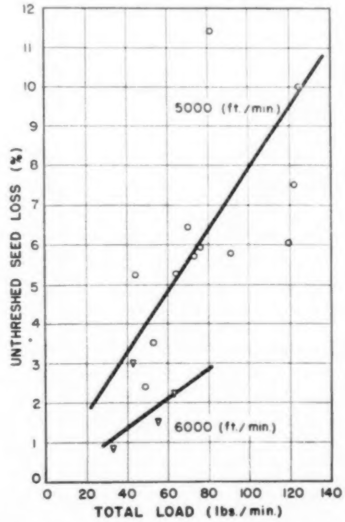


Fig. 5 Effects of cylinder speed and feed rate on the loss of unthreshed Kenland red clover seed. Combine equipped with rasp-bar cylinder and flax rolls. Cylinder clearance, 0.065 to 0.090 in. Normal feed rate is from 35 to 50 lb per min

10 lb per acre are usual, although losses of only 2 lb per acre have been observed. In Ladino clover, under good conditions, with level fields and with the header modified to permit cutting within ½ to ¾ in above the ground, losses may be as low as 15 to 20 lb per acre. Less favorable conditions, though, may easily double these losses. Cutter-bar losses for the other legumes fall between the extremes represented by alfalfa and Ladino clover.

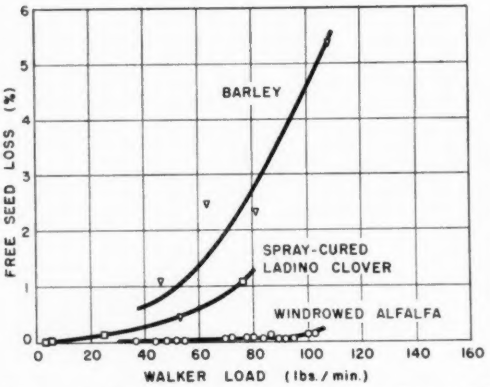
RESULTS

Seed Damage

Peripheral speed of the cylinder is the most important factor in seed damage, as brought out by Jones et al (1). Fig. 2 shows how an increase in cylinder speed reduced the percentage of germination of alfalfa seed.

Seed damage is reduced as the load in the cylinder is increased (Fig. 3).

Damage is generally low when the moisture content of the seed is high. High moisture content in the straw and greater leafiness provide padding which also reduce damage. Clearances in the cylinder, augers, and elevators are of little importance in seed damage until they approach the maximum seed dimension. Damage to seed in the tailings



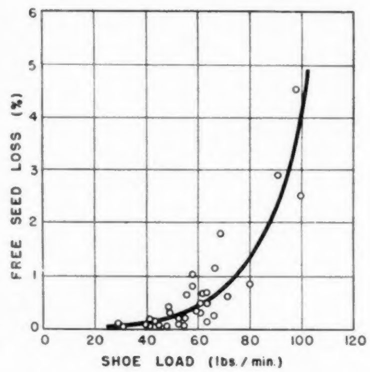


Fig. 6 *(Left)* Loss of free seed over the straw walkers as affected by walker load rate. Standard, four-step grain walkers. Normal walker load rate: alfalfa, 20 to 45 lb per min; Ladino clover, 5 to 40 lb per min • Fig. 7 *(Right)* Effect of load rate on loss of free seed over the cleaning shoe. Riffle chaffer with finger-type chaffer extension. Data obtained from three combines operating in the same alfalfa field. Machines similar except for type of cylinder. Shoe loads at normal operating speeds ranged from 20 to 45 lb per min

seed damage. These two factors may vary directly or inversely. For example, Ladino clover seed is difficult to thresh, but high peripheral speeds can be used because the seed is not easily damaged, whereas red clover is very difficult to thresh, and it is easily damaged. On the other hand, alfalfa is easy to thresh and damage becomes excessive at medium peripheral cylinder speeds.

Jones et al (1) found that flax rolls effected an improvement in the threshing performance for alfalfa seed. As a result of their studies, flax rolls are commonly used to harvest small legume seeds in California. The cylinder speed can be reduced on combines equipped with flax rolls without loss of threshing efficiency, which results in lower seed damage. The rolls also provide the added advantage of making the feed rate into the cylinder more uniform, which favorably affects threshing efficiency and seed damage. As a result of these studies, the cylinder speeds and clearances given in Table 1 have been set up for California seed growers.

is slight, even though 10 to 20 percent of the total seed load in the harvester may be circulating in the return.

At the end of the season, germination tests were run on the samples that had been examined for harvester damage. The correlation was very close between percent visible damage and the percent of seed that failed to germinate or that which produced abnormal plants.

Threshing Operation

Under California conditions, a combine in small-seeded legumes must handle from 1½ to 3 tons of straw and chaff per acre, and is normally operated at forward speeds of ½ to 1 mph. The resulting feed rates in alfalfa seed harvesting generally range from 40 to 90 lb per min, while they are usually somewhat lower in Ladino clover. When properly adjusted, the unthreshed seed loss for a particular size of combine is about proportional to the rate at which material is fed into the machine. Fig. 4 shows the relation between feed rate and unthreshed seed losses for alfalfa seed, a crop that is relatively easy to thresh.

Fig. 5 shows the effects of cylinder speed and feed rate on threshing efficiency for Kenland red clover, the most difficult to thresh of the listed crops. While a much better job of threshing resulted at 6000 fpm, there was danger of excessive seed damage at that speed.

The particular peripheral cylinder speed used to harvest any of the small legume seed crops is the result of a compromise between thoroughness of threshing and amount of

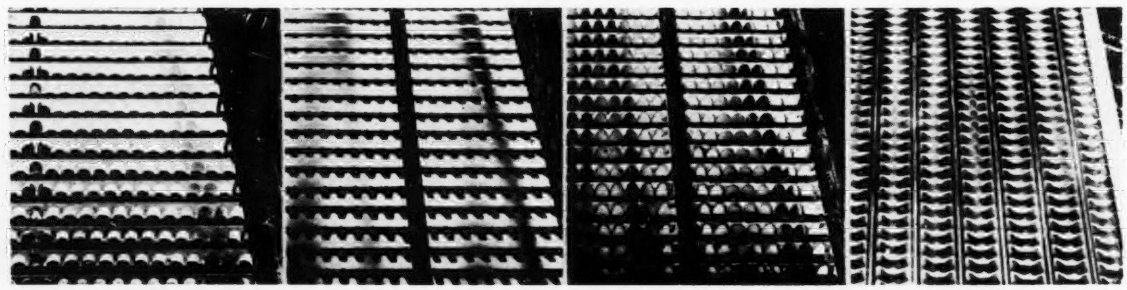
TABLE 1. RECOMMENDED CYLINDER SPEEDS AND CLEARANCES

Crop	Peripheral speed, fpm Spray-cured	Windrowed	Clearance, in
Alfalfa			
(with flax rolls)	4000–5000	3600–4400	$\frac{1}{8}$–$\frac{3}{8}$
(without flax rolls)	4000–5000	4200–4800	
Red and alsike clover			
(with flax rolls)	5300–6000	4800–5500	$\frac{3}{32}$–$\frac{3}{16}$
Ladino clover (with or without flax rolls)	6000–9000	5000–6000	$\frac{1}{16}$–$\frac{1}{8}$
Trefoil (with flax rolls)	5000–5500	5000–5500	$\frac{1}{4}$–$\frac{1}{2}$

Straw Walker Performance

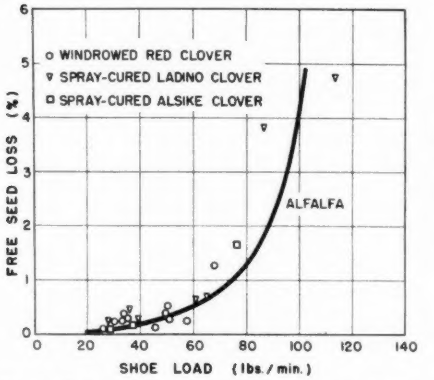
Free seed losses over the walker (or rack) increase with load, but more rapidly than the load. Typical walker losses for alfalfa and Ladino clover are shown in Fig. 6. A curve based on limited tests with barley is included for comparison.

In harvesting small-seeded legume crops under California conditions, the walkers carry a smaller portion of the



A B C D

Fig. 8 Portions of chaffers tested: A, riffle; B, adjustable lip; C, Peterson; D, no-choke



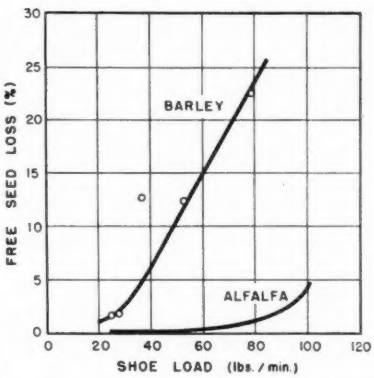


Fig. 9 *(Left)* Effect of seed size on cleaning-shoe performance, showing free seed losses for various small-seeded legumes, all harvested by the same or similar combines. Curve for alfalfa seed is from Fig. 7, points not plotted. Peterson chaffer (⅝ in open) used for Ladino clover, adjustable lip chaffer (½ in open) used for alsike clover, and riffle chaffer used for red clover • Fig. 10 *(Right)* Free seed loss over the cleaning shoe for alfalfa seed, as compared with results of limited tests with barley. Riffle chaffer with finger-type chaffer extension. Curve of alfalfa seed loss is from Fig. 7, points not plotted

total combine load than they do in grain harvesting. The limited tests in barley showed that the walkers retained two-thirds of the total weight of straw and chaff passing through the machine. When harvesting wheat under Midwest conditions, McCuen and Silver (2) found that 90 to 95 percent of this total weight was retained on the straw rack. In windrowed alfalfa, the walkers handle about half of the total load, while in windrowed red clover, the walkers carry less than one-third of the total straw and chaff. In spray-cured crops, the straw has a higher moisture content and does not break up as badly. As a result, a higher percentage of the straw and chaff is retained on the walkers. Generally, as the load rate increases, the walkers carry proportionally more of the total load. Numerous attempts have been made to improve the performance of combines in small-seeded legume harvesting by covering the walkers with fine mesh material. While this action has helped reduce the load on the shoe, it has generally resulted in a considerable increase of seed losses over the walkers.

Cleaning Shoe Performance

When harvesting small-seeded legumes, the cleaning shoe must handle a relatively large amount of chaffy material separating seeds that are minute in comparison with the cereal grains — 200,000 to 800,000 seeds per pound as compared with 8,000 to 24,000 for barley and wheat (4). For the small-seeded legumes, the shoe is therefore adjusted for maximum seed recovery rather than for a good job of cleaning, as is customary in grain harvesting.

The load on the shoe is a major factor in determining the level of free seed loss and unthreshed seed loss over the shoe. The relation between load and free seed loss for the riffle chaffer (Fig. 8) is shown for alfalfa seed in Fig. 7.

The size of the legume seed does not in itself seem to be a major factor in separating efficiency for free seed, as indicated by Fig. 9. The average number of seeds per pound for the crops of Fig. 9 has been found to be: alfalfa, 200,000; red clover, 275,000; alsike clover, 680,000; and Ladino clover, 800,000. The losses for Birdsfoot trefoil (500,000 seeds per pound) also follow the curve of Fig. 9 rather closely. The small difference in separating efficiency among these crops, whose seed weights have a ratio as high as 4-to-1, may seem unreasonable until it is considered that the ratio of their settling velocities is only about 1.3-to-1 or roughly the sixth root of their weight ratio. Consequently, to recover Ladino clover seed, the wind on the cleaning shoe need be reduced only about 25 percent below that used for alfalfa seed. The one difference is that the clover seed generally has a mill cleanout of 30 to 40 percent, as against 10 to 20 percent for alfalfa seed. The curve and points shown in Fig. 9 are not directly comparable because of this difference in cleanout (since the loss percentages were calculated on the basis of the weight of seed as it came from the grain spout).

The limited points plotted for barley in Fig. 10 indicate the magnitude of the difference between the free seed losses over the shoe for barley and for alfalfa when the harvesters are properly adjusted to harvest these crops under California conditions.

Fig. 11 *(Left)* Effect of fan opening (or amount of wind) on performance of the cleaning shoe, showing the loss of free seed and the amount of tailings circulating in the return system. Average shoe load, 46 lb per min. Riffle chaffer with finger-type chaffer extension. Tests were run at a constant fan speed • Fig. 12 *(Right)* Performance of various chaffers in alfalfa seed harvesting. Curve for riffle chaffer is from Fig. 7, points not plotted. The other chaffers were all tested in the same machine on the same day

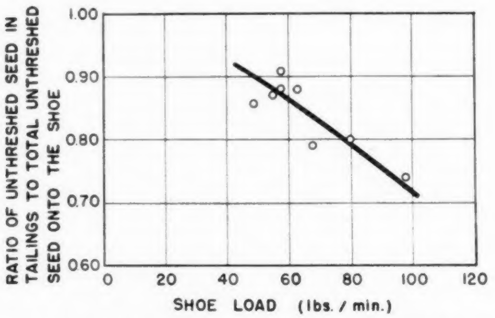


Fig. 13 Effect of load rate on recovery of unthreshed alfalfa seed by the cleaning shoe. The total unthreshed seed onto the shoe was determined by adding the unthreshed seed lost over the shoe to the unthreshed seed recovered in the tailings. Riffle chaffer with finger-type chaffer extension

The amount of wind on the cleaning shoe can seriously affect the separating efficiency, as is indicated by Fig. 11. The sharp increase in free seed loss is due to wind velocities on the shoe that exceed the settling velocity of the seed. The increase in free seed loss as the amount of wind is decreased is due in part to a greater load on the shoe, which is caused by the increased recirculation of tailings.

There is some difference in the efficiency of chaffers, as indicated by Fig. 12. The adjustable-lip chaffer has shown consistently good performance in all tests. The double no-choke chaffer, which consisted of a No. 0 no-choke, about 3 in above a smaller No. 2 no-choke, performed very well in the series of tests shown in Fig. 12, but did not perform as well in red clover. At normal load rates and when properly adjusted, the riffle, Peterson, and adjustable-lip chaffers show relatively little difference in performance.

In small legume seed harvesting, a considerable portion of the seed passes through the cylinder unthreshed. The majority of this unthreshed seed is normally recovered in the separating operation and returned to the cylinder for re-threshing. The remaining unthreshed seed is lost over the back end. Consequently, the loss of unthreshed seed is closely related to the efficiency of the separating mechanism. Fig. 13 indicates that the effectiveness of recovery of unthreshed seed is reduced as the load on the shoe is increased.

Recovery of unthreshed seed improves as the chaffer openings are increased, as shown in Fig. 14.

This same effect is also evident in the recovery of free seed (see curves for adjustable-lip chaffer, Fig. 12) in spite of the accompanying increase in tailings. Adjustable-chaffer openings of about ½ in (measured at right angles to the axis of the openings) have proved satisfactory for machines with adequate return capacity. In alfalfa, with a ½-in chaffer opening, the material load in the return system varies from 50 percent to well over 100 percent of the net shoe load (material discharged over the rear of the shoe). In green or improperly cured material, the openings have to be reduced, to keep the return from plugging. This results in decreased separating efficiency.

SUMMARY

1 Successful harvesting of small-seeded legumes depends as much on the cultural practices used to produce the seed crop as on the operation of the harvester. Combines, when properly adjusted, are capable of doing a good job of harvesting these crops, although most machines require some modification for the best performance.

2 At normal load rates, the factors affecting combine performance in small-seed legume harvesting are:

(a) Cylinder speed is the most critical factor in causing seed damage (and reduced germination)

(b) Unthreshed seed constitutes the largest single loss from the combine

(c) Loss of free seed over the straw walkers varies considerably, depending on the crop and its condition, but is usually not high for small-seeded legumes

(d) The cleaning shoe, when properly adjusted, does an excellent job of recovering free seed.

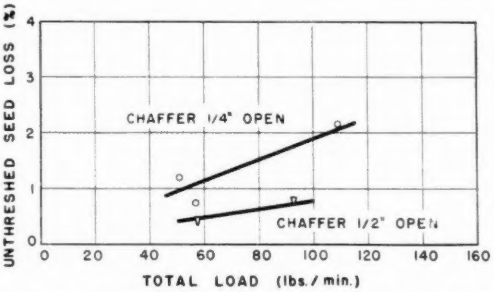


Fig. 14 Effect of chaffer opening on the loss on unthreshed alfalfa seed. Adjustable lip chaffer with finger-type chaffer extension

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"Graphic Presentation of Mathematical Equations"

TO THE EDITOR:

I thank you kindly for sending me a copy of the June, 1954, issue of AGRICULTURAL ENGINEERING with its excellent lead article on "Advantages of Graphic Solutions of Mathematical Equations." I have been working for a number of years to encourage this point of view and am naturally gratified each time I find that persons in new fields have come to share it. The article is comprehensive, clear, and convincing. It has a basic philosophy with which I am very sympathetic. On all these points I am sure I speak for others in this field who have been making a similar effort.

I should be glad to help you in any way I can should you ever decide to publish further articles of this nature, especially if they appear to involve more difficult cases.

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Functional Design of Farm Buildings

John C. Wooley
Fellow ASAE

Background Needed by the Student for Preparation in This Field

THE term functional design does not have the same meaning to all people. Agricultural engineers are not in exact agreement as to where it begins and where it ends, but all agree that it has to do with use and service.

The product development divisions of farm machinery manufacturing companies are concerned with functional design of farm machines. To do this design they must know about crops, soils, agricultural procedures and practices as well as engineering. When they have created the part to do each step in the process to be accomplished, when these parts have been assembled in proper relationship to each other and synchronized to work as a unit, then functional design has been completed and the machine is ready for structural design. Functional design makes the machine useful to the farmer and structural design gives it the strength and durability necessary for long service.

Functional design of farm buildings offers a parallel case, and perhaps it can be agreed that the over-all objective of functional design is to make buildings that will render effective and satisfactory service to the enterprise housed.

Today's farm buildings need special emphasis on functional design, to serve the new type of agriculture.

The changes in the last two decades require that some of the customs and traditions in design be dropped and a fresh start taken. This does not imply that any of the science established nor all the traditions of the past must be discarded, but that accumulated knowledge and the principles we have proven be used, in a modern realistic approach to the problem. Deane G. Carter's paper "Challenges Awaiting Agricultural Engineers in Farm Structures" (1)* presented at the Centennial of Engineering Convocation gives ample evidence of the need for this new approach.

The first step in training for functional design in buildings should be to establish a background of information concerning the changes referred to and their effect on the problem. I will mention six of these changes briefly in order to show their importance to the problem.

First, I would suggest consideration of the changes in farm management aims and objectives. Twenty years ago farmers felt the need for diversifying their business. The slogan of the time was "Do not carry all of your eggs in one basket." They felt this to be necessary in order to avoid total failure. This was horizontal diversification.

Today's agriculture with its greater stability in production and with its increased tendency toward business farming calls for emphasis on *vertical diversification*. This plan discourages the sale of raw products, as such, and encourages their change (manufacture) into milk, meat, eggs, wool, etc., for sale in a better market. Vertical diversification is being carried another step in many cases where these first-step products are processed, packaged and sold direct to the customer.

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*Numbers in parentheses refer to the appended bibliography.

Sale of raw products in agriculture has always been associated with a low standard of living (peasantry).

Vertical diversification requires livestock farming and fits into the next important change, *improved use of land*. In this program many farmers have controlled erosion and started to build up their capital stock, the soil. This insures continuing and even increasing productivity for the years ahead making long-time planning possible.

The third important change comes from the improvement that has been made in the crop and animal enterprises. This improvement in crops is best exemplified by hybrid corn. The improvement in animals is due to breeding and scientific feeding.

The fourth change, a strictly agricultural engineering product, comes from the development of mechanical power and machinery for the farm. It has changed not only the source of power but the whole operating system as well. Today's farmer is equal to two or three 1930 farmers in many field operations.

These changes affect functional design of buildings in that the tonnage of crops to be handled and the number of animals to be cared for has been doubled and at the same time the help available to do this work has been reduced by at least 50 percent. The bottleneck once in the field operations has shifted to the farmstead.

Many of the farmers in our balanced farming program are forced to remodel their buildings, farmsteads and field layout in order to keep their manufacturing ability in balance with their ability to produce raw materials.

Other changes that affect functional design come from specifications set up by consumers represented by the boards of health. Meeting these requirements enables the farmer to maintain quality in the products he has to sell. Veterinarians have set up specifications and procedures which, although they are not laws, require strict observance if the farmer wishes to succeed.

Our own research in cooperation with the animal physiologists, dairy scientists, agronomists and plant pathologists is elevating farm building design out of the realm of opinion and placing it on a foundation of science.

We have been so close to these changes that they often seem to be just ordinary developments, but when we move back and gain perspective, they have all the marks of a peaceful revolution in agriculture.

Two or three sessions in our training course may be used profitably in establishing this background and developing the general objectives of the course. The student in functional design needs this preparation as the products development men need a knowledge of soils, crops and agricultural practices.

With this background and with a foundation in basic science the young agricultural engineer has the foundation needed for study of functional design of farm buildings.

A friend believes in what he calls the natural way of learning. He explains it this way. When anyone comes into possession of a new gadget, he tries first to find out

what it is for; and then he wants to know how it works, so he takes it apart. If this dissection is done under the supervision of one who knows about the particular gadget, the learner will find out about the function of each part and will be able to put it together again.

A more dignified presentation of this method is given in a book, "How to Use Your Mind Effectively"(2) by J. L. Mursell, professor of education, Columbia University.

The over-all objective of functional design—providing buildings that will render effective service to an enterprise presents a vague and imposing problem with no place to take hold to secure a solution. Following the plan suggested by my friend we can take it apart. We can first divide it into three parts: (*a*) provision for efficiency in the use of the farmer's time, (*b*) furnishing a working environment for the animals or fowl, and *(c)* meeting the requirements for quality production.

These are more definite but still too large for effective study. Taking the first part, provision for efficiency in the use of the farmer's time, we can divide it on the basis of different tasks to be done.

For the sake of more definite illustration, I would like to apply the method to a common farm enterprise, the production of market milk.

In this enterprise these tasks to be done would be: *(a)* the milking operation, (*b*) feeding, (*c*) daily chores, (*d*) intermittent, and (*e*) seasonal operations. As we make further division, the details of the picture seem to clear up so that we can find a place to get hold.

For the purpose of making this division in the milking operation, data from time studies furnish excellent information (3). Using the figures as they were secured in the study and assigning students the task of finding the relative importance of each step in the process, the average time required per cow and per 100 lb of milk acquaints him with all the different operations involved.

If test data is available from a number of farms having the same layout, it enables the students to determine the difference in operators. If tests are available from farms having different plans, a comparison of plans can be secured. Comparison can be made of parallel stall with the straight tandem arrangement or with U-shaped or with parallel tandem stalls. The saving by use of pipe-line milkers can be determined.

If averages or standards are available a comparison with them enables the student to evaluate the plans studied and to locate points where improvements are needed.

From this experience the student begins to build up a fund of information that is more meaningful to him than that secured from the printed page or the lecture.

Time studies do not give information for accurate rating on all cases and they cannot be used in measuring the efficiency of new designs until a building has been erected and put into use.

A travel study is better adapted to finding good and bad features in plans. It can be made from a scale drawing by setting pins or small nails at each terminal point in the travel of the operator, following them with a thread or cord to secure the distances for different operations. Where a floor plan and yard layout of the farms where time studies were made can be secured, a travel study will be valuable. The data secured will enable the student to measure the value of his own designs later. With this experience back of them students will profit by a field study of a dairy farm. After making a general inspection of the layout a part of the class may make a time study and the remainder may be given the task of securing data for a scale drawing to be used for a travel study.

The field trip gives the student the opportunity to observe a working enterprise, and it is worth the considerable effort required in arranging for and carrying it out.

Time and travel studies are deficient in two respects: first, they give no recognition to the relation between the position of the work to be done and that for most efficient accomplishment (4); second, they do not take into account the variations in the energy requirement for different parts of the operation. Elevating the milking stalls illustrates a method for changing the position of the work into a more efficient working area. When convenient methods are available for measuring the energy required for different jobs, time and travel studies can then be weighed for a more accurate rating of plans.

Travel studies can be made on the feeding, chore, intermittent and seasonal operations as a method of setting up standards, determining the relative importance of different operations, and measuring the value of designs.

The method of routing the flow of material, animals,

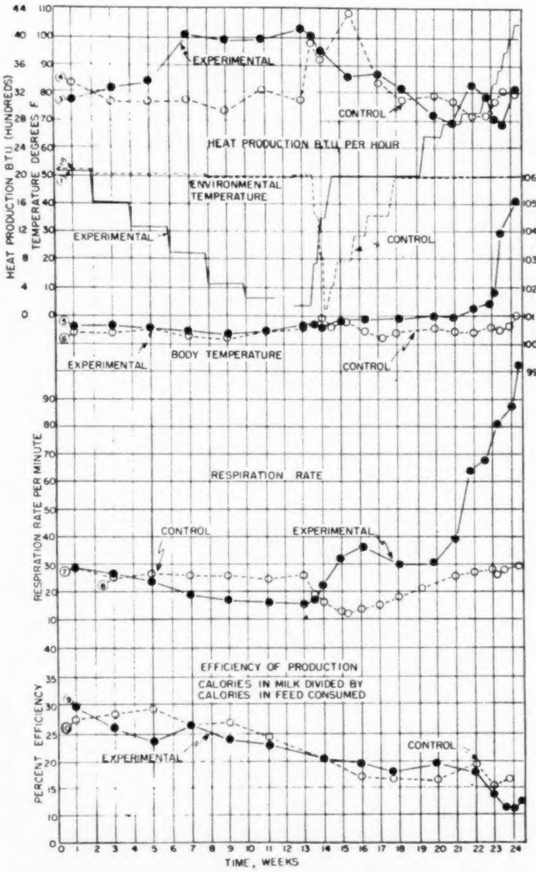

Fig. 1 Physical reactions of cows under different environmental temperatures

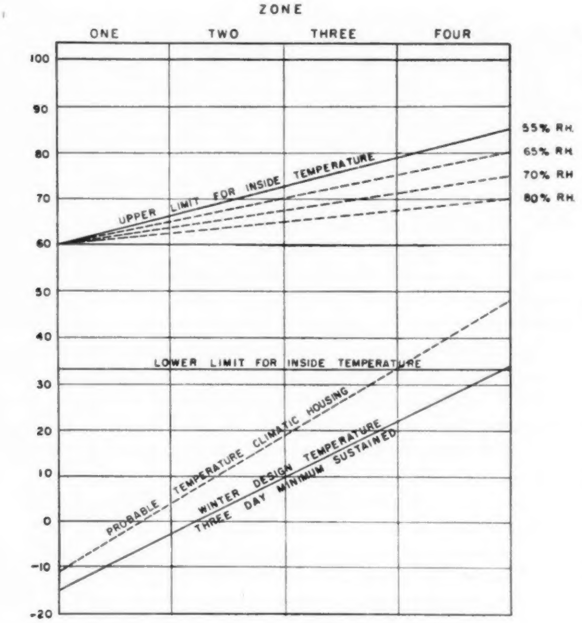

Fig. 2 Design data for different zones

finished products, waste materials, etc., offers help in making the general layout (5, 6).

Our problem in the enterprise chosen for illustration differs from those in a typical factory. We are dealing with automatic machines that can move to the raw materials, help themselves to a day's supply, find a comfortable spot in which to do the manufacturing, and then come to the place prepared for delivery of the product. In many cases the cows can be routed to the material instead of routing the materials to the cows and an important saving secured.

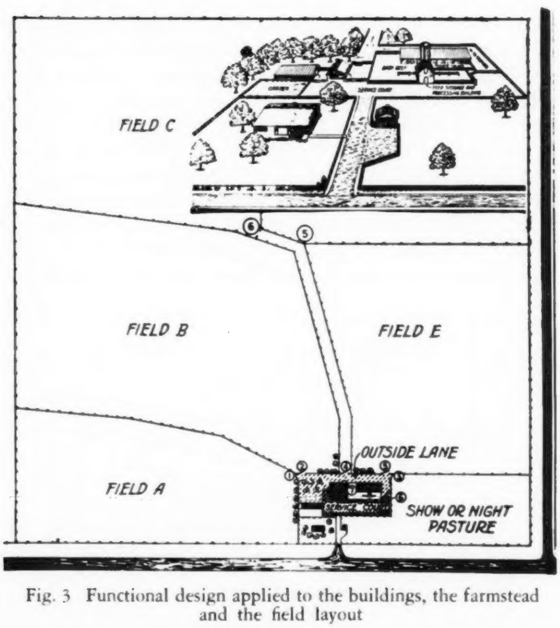

Fig. 3 Functional design applied to the buildings, the farmstead and the field layout

Self-feeding hay mangers or barns, self-feeding silos, automatic all-weather watering places, feed elevators and conveyors, gutter cleaners, manure loaders, tractor and machinery passes and the like contribute to the saving in general operation that we must have to bring our farmstead efficiency up to the standards needed on today's farms.

At this point in the course the student is ready to use the information he has acquired in a design problem involving only the layout for efficient operation.

We are ready now to consider the second of the specific objectives, the provision of a *working* environment for the cow. The adjective "working" is emphasized because manufacturing is an active process and the cows need an environment for work rather than one for relaxation.

At this point in our study of environmental needs, we must make a division of the problem based on the type of housing to be used.

There are two types. In one the various factors that make up the environment are controlled within specific limits throughout the season. Cows that are housed through the fall season in this controlled environment become dependent on the barn for its continuation through the winter period. The term "controlled housing" is used for this type. If we use open-type buildings and expose the cows to the seasonal rhythm, nature provides them with protection against cold as long as they are shielded from rain, snow, and winter winds. For want of a better term I am calling this "climatic housing." This type of housing necessitates loose-housing management. In cold weather the cows move about, they huddle to secure the benefit of radiant-heat exchange, and they gain some heat from the manure pack normally used with this type of management.

In the study of either type we can divide our problem on the basis of the measurable factors in the environment, namely, temperature, humidity, air movement and light. For study of each we can check the effect of variation by observing the physical reactions of the cows (Fig 1). For example, in determining the upper and lower temperature limits for best production, we can observe the respiration rate, pulse rate, body temperature, heat production in all its ramifications, and the amount and efficiency of production. Variation from the normal in these reactions, as temperature of the environment is raised or lowered, establishes the limits of the thermoneutral zone (7, 8, 9). The lower temperature limit is very indefinite depending on the size and breed of cows, the amount of feed being consumed, and the degree of acclimatization. The upper limit is much more definite, and when it is reached the physical reactions increase rapidly with any further increase in temperature.

Studies on the effect of variation in the humidity of the environment indicate that at low and medium temperatures it is of minor importance so far as production is concerned. However, its effect on health, sanitation and on the building may be of sufficient importance to control the design.

In high temperatures humidity is very important. The upper temperature limits for the thermoneutral zone in Fig. 2 show the effect of humidity. In the laboratory, cows that were seemingly very comfortable at 85 deg and a low relative humidity, were in distress in a short time at the same temperature with an increase in humidity. Air movement has a lesser effect on the test cows than might be expected but

(Continued on page 564)

Harvesting Small Grass and Legume Seed

Joseph K. Park
Member ASAE

THE Agricultural Engineering Research Branch of the U.S. Department of Agriculture and the South Carolina Experiment Station have conducted cooperative studies during the last three years to determine the effectiveness of various equipment and methods used in harvesting small grass and legume seeds. This paper discusses the results of these studies.

The Southeast produces over one-half of the United States' supply of lespedeza, crimson clover and tall fescue seed. In addition, smaller acreages of other grass and legume seed crops are harvested in some areas. Harvesting of these seed crops in the Southeast is done principally by direct combining with small power take-off combines which are available on most farms for harvesting the grain crops. As a result of weather shattering and harvesting, losses may vary from 25 to 100 percent.

Crimson Clover

In tests at Clemson, incomplete threshing has been the most serious source of crimson clover seed loss in the harvesting operation. From 8 to 40 percent of the seed has usually been lost in the chaff as unthreshed seed. Therefore, the primary object of studies in this crop has been to determine the effect of various cylinder designs and cylinder adjustments on threshing efficiency. In 1952 and 1953 six makes of combines were included in tests intended primarily to compare cylinder performance. Measurements were made to determine unthreshed seed loss, threshed seed loss, damaged seed, clean seed yield, trash content, and moisture content. Cylinders of all combines were run at approximately the same peripheral speed and clearance throughout most of these tests, and ground speeds were adjusted in 1953 to give a uniform feeding rate to the cylinders. Various changes were made on cylinders between tests. Treatments were replicated 8 times in all tests.

The most significant conclusion from these tests was that the angle-bar cylinder threshed out a higher percent of seed than the other cylinders, and at the same time damaged less seed. In 1952 the angle-bar-cylinder combine gave a higher clean seed yield and lower unthreshed seed loss than any other combine in each of three tests. The spike-tooth cylinder threshed out a higher percent of seed than the rasp-bar cylinders. In most of the 1953 tests the angle-bar cylinders were significantly higher in threshing efficiency than other cylinders. Angle bars or channel bars were added to rasp-bar cylinders in several combines and in every case the result was improved threshing efficiency. Sixteen angle bars instead of the usual eight were installed in an angle-bar combine for one test, and, contrary to expectations, the result was a decrease in threshing efficiency. Seed damage was determined by visual inspection and by germination tests and was found to vary from about 2 to 4 percent for the angle-bar cylinders and from 5 to 12 percent for the rasp-bar cylinders. Rubber was removed from angles, concaves, and shelling plate of the angle-bar cylinder in one test, and, although seed damage increased slightly, it was still much less than damage from the rasp bar cylinders. Cleaning loss (loss of threshed or free seed) ranged from about 1 to 25 percent and was generally much less than threshing loss. Combines which were not equipped with a raddle conveyor to feed the cleaning shoe had the highest cleaning losses. In one of these machines where cleaning loss was exceptionally high, it was observed that considerable material accumulated ahead of the cleaning shoe and was very unevenly distributed on the top chaffer.

Cylinder speed and clearance are very important in threshing crimson clover. In general, clearance should be as small as practicable and speed should be as high as practicable within the limits of adjustments provided. Cylinder-speed tests were conducted with an angle-bar and a rasp-bar cylinder in 1953 and the effects of cylinder speed changes have been determined in other tests. Increase in cylinder speed has invariably resulted in lowering unthreshed seed loss and increasing clean seed yield. Figs. 1 and 2 show this in a typical example of the effect of cylinder speed. Seed damage is increased by using high cylinder speed and in one

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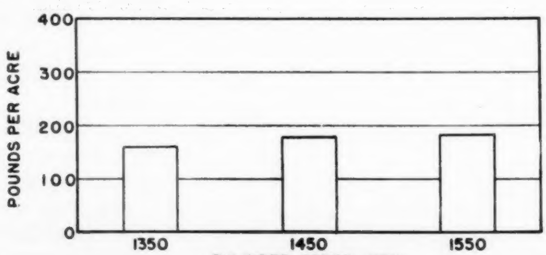

Fig. 1 Effect of cylinder speed on clean-seed yield of crimson clover

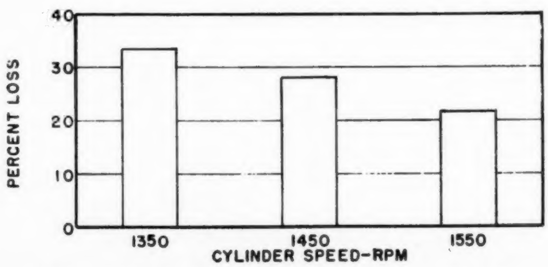

Fig. 2 Effect of cylinder speed on unthreshed seed loss of crimson clover

case visible damage was as high as 13.4 percent when a rasp-bar cylinder was run at 1760 rpm (7800 fpm) in very dry clover. However, even in this case the rate of increase in seed damaged was not enough to offset the rate of increase in seed yield, and germination tests did not show appreciable damage, although the percent of hard seed was decreased.

Ground speed, or cylinder feeding rate, is also important in harvesting crimson clover. Fig. 3 shows the results of a ground-speed test in 1953. Within the speed range of 1.5 to 3 mph used in this test, clean seed yield decreased considerably when the ground speed was increased. This was a result of poorer threshing and cleaning at the higher feeding rates. Slower speeds than used in this test might further increase yields; however, the farmer must balance the advantage of slower speed against the possibility of rain shattering his crop and would probably not go much slower than 1.5 mph. Also, this is about the slowest speed at which most current tractors will operate power-take-off combines.

Shattering losses are often very high in harvesting a crimson clover seed crop in the Southeast. Our measurements of cutter-bar losses in direct combining have averaged about 10 percent, and weather shattering may vary from about 10 percent in favorable conditions to nearly a total loss from a bad storm on a mature, standing crop. Weeds, uneven or delayed maturity of plants, and frequent rains often complicate harvesting. Therefore, under some conditions, it may be advisable to use chemical defoliants or to mow the crop, combining later with a pickup attachment. Tests were conducted in 1952 and 1953 to compare the effectiveness of these methods. In 1952 seed yield was higher by direct combining than by harvesting from windrows, and chemical defoliation was of no value. In 1953 the crop matured slowly and conditions were more favorable for defoliation and windrowing. Chemical defoliation increased yield almost one-third, but this increase was partially offset by shattering loss caused by tractor wheels in applying the chemicals. Moisture content of the seed was reduced by defoliation. Combining from windrows and swaths gave more seed than direct combining in a test harvested relatively early. However, plots not subjected to rains and direct combined from the same area at later dates increased in yield to equal those harvested earlier from the windrow and swath. The advantage of mowing in this field was to permit earlier harvesting. Combining from the swath gave a higher yield than combining from the windrow, and the swaths dried much faster. Swaths were ready to combine in two days as compared to four days for the windrow. Seed combined from the swath or windrow is much drier than direct combined seed and can be stored without danger of heating.

Deciding when to harvest is always a problem for the crimson clover seed producer. Time of harvest tests in 1953 (Fig. 4) indicated that seed yields increase until the entire crop is dry and mature unless rains occur. In this test, no rain occurred until June 4 when a storm shattered much of the seed. To avoid the chance of severe weather shattering, it is advisable to start harvesting when about 80 percent of the seed heads strip easily by hand. If the crop is to be harvested from the windrow or swath it should not be mowed before 50 percent of the seed heads strip easily by hand. A study conducted in cooperation with C. H. Arndt, botany department, South Carolina Agricultural Experiment Station, shows that germination of seed will be low if the crop is mowed before this stage of maturity. This study also showed that germination of seed from any green-colored seed head is very low regardless of date harvested. This fact should be of some help in deciding on time to harvest.

Crimson-clover harvesting tests for 1954 have just been completed and results have not yet been analyzed. However, preliminary conclusions which can be drawn from some of the tests on the basis of field weights are as follows: An angle-bar and rasp-bar cylinder were interchanged in one combine and seed yield was considerably higher from the angle-bar cylinder. In a similar test with another manufacturer's combine, seed yield was higher from the angle-bar than from the rasp-bar cylinder. A tined pickup reel improved cutting and increased seed yield. A power-driven reel on one combine caused considerable shattering ahead of the cutter bar, resulting in a definitely lowered yield. A test of an open-versus-closed grate showed about 16 percent higher yield from the closed grate. Removal of the shelling plate or back concave of an angle-bar cylinder machine resulted in about a 7 percent decrease in yield. A cylinder clearance test with an angle-bar cylinder showed about a 5 percent decrease in yield when clearance was increased from 1/16 to 1/4 in. Defoliation and swathing did not result in increased yields. There was no difference between the yield from rubber-covered and metal angle bars.

Fescue

Shattering from weather and cutter bar are the most important seed losses in fescue. In a test to measure these losses in 1953, weather shattering was 35 percent and cutter-bar loss was 23 percent. A test was conducted in 1952 to see if shattering loss could be reduced by windrowing. The result of this test was that shattering losses were considerably higher when harvesting from windrows than when direct combining. Raddle and drum-type pickup attachments were used in this test and caused high shatter loss in picking up the windrows. Draper-type pickup attach-

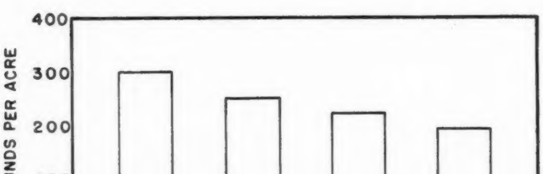

Fig. 3 Effect of ground speed on clean-seed yield of crimson clover

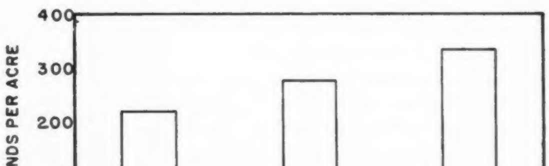

Fig. 4 Effect of time of harvest on clean-seed yield of crimson clover

ments are generally much more satisfactory for harvesting seed which shatter easily.

Threshing and cleaning losses are generally quite low in combining fescue if the combine is properly adjusted. The seed are easy to thresh and loss over the straw rack is negligible. Cleaning loss appears to be high when observing the chaff from the combine, since the immature seed and glumes resemble mature seed. However, when good seed is separated from this material, cleaning loss has generally been less than 2 percent.

A test was conducted in 1952 to determine differences in performance of three makes of combines in harvesting fescue. Threshing and cleaning losses were low for all three machines and, therefore, there was no important difference between yields harvested. There was, however, some difference in the amount of trash in the seed.

Sericea Lespedeza

The greatest losses in harvesting Sericea lespedeza seed are caused by weather and cutter-bar shattering. Defoliation and windrow harvesting tests have been conducted to determine the effect on shattering losses and seed yield. Thus far there has been no significant difference between seed yields harvested by these various methods.

Kobe and Korean Lespedeza

Weather and cutterbar shattering are the major losses in harvesting Kobe and Korean lespedeza seed. Measurements were made to determine these losses in a Kobe field in 1953. It was estimated from these measurements that weather shattering and cutter-bar loss each amounted to about 150 lb per acre, a total shattering loss of 300 lb. In comparison, the total clean seed yield in this field averaged 350 lb per acre, or only slightly more. The University of Tennessee has made extensive studies of lespedeza seed losses with various harvesting equipment and the results are reported in their Bulletin No. 171 by H. A. Arnold. These studies showed that direct combining resulted in lower seed losses than the other harvesting equipment or methods tested. Lespedezas in South Carolina are at present harvested almost entirely by direct combining. A local farmer has developed a cutter-bar attachment for salvaging lespedeza seed shattered by the sickle. The attachment consists of a small trough and auger which mounts below the sickle, and a small conveyor. Slots are cut just behind the sickle to allow seed to fall in the auger trough. Several tests with this attachment in Kobe and Korean lespedeza have resulted in seed yield increases of from 10 to 25 percent, depending on crop condition.

Threshing and cleaning losses are generally low in harvesting lespedeza. When mature, all lespedeza is easy to thresh and cylinder adjustment is not critical. Some attention must be paid to the amount of scarification, and cylinders are generally run relatively slow and with wide clearance. Cleaning loss should not be over about 2 percent if the combine is properly adjusted.

Lespedeza cutter bars give considerable trouble in harvesting lespedeza in this area; standard cutter bars perform much better. Wheat straw remaning in the field clogs the lespedeza bars but causes very little trouble with standard cutter bars.

Summary

Studies conducted to date in South Carolina show that weather and cutter-bar shattering cause the greatest losses in harvesting fescue and lespedeza seeds. However, in crimson clover threshing loss is the major problem, and angle-bar cylinders have been preferable to other types in harvesting this crop. Direct combining appears generally to be the best method of harvesting these crops in South Carolina. Chemical defoliation may be profitable in some cases but further tests are necessary to determine its value.

Cylinder speed and clearance and ground speed are very important in harvesting crimson clover. Under the humid conditions usually present in this area, cylinder speed should be as high as possible and clearance as small as possible without causing excessive damage of seed. Ground speed should be as low as practicable.

Functional Design of Farm Buildings

(Continued from page 561)

as in the case of humidity other requirements may indicate some control.

Climate is an important factor in the design problem. It is sufficiently important to warrant a new look at building zone layout. I would suggest consideration of three zones: *(a)* where the conservation of heat is a major requirement in design, *(b)* the area where both conservation and dissipation of heat must be considered, and *(c)* the area where dissipation of heat and protection from it are the major requirements. The latter zone is being given considerable attention, indicated by late publications in AGRICULTURAL ENGINEERING. It has an important place on this program and will no doubt have the attention of research workers and designers for some time in the future.

The third of the specific objectives, the provision of conditions for maintenance of quality in the finished products, may be divided on the basis of *(a)* providing a healthful environment for animals or fowl, *(b)* reducing contamination from waste material, and *(c)* controlling the growth of harmful bacteria. Division of these objectives on the basis of the methods available for attaining them will provide the approach needed for effective study.

When the student has gone out from the general objective into the many details involved in its attainment and has worked his way back to this objective with understanding, he should have reached one of the goals of education, the ability to do creative thinking — in this instance, in the field of functional design of farm buildings.

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Machine Harvests Gladiolus Corms

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Member ASAE Member ASAE Assoc. Member ASAE

Oregon Agricultural Engineers Develop Harvester to Reduce Labor Cost and Speed Harvesting

HIGH labor costs and the necessity of speed in harvesting ahead of untimely rains are the factors which caused Oregon growers to demand a gladiolus corm harvester. Labor is high in Oregon as compared with foreign countries and other parts of the United States where gladiolus are produced. On the other hand, because of their distance from markets, Oregon growers must produce corms at a low price in order to compete with foreign importations and also to pay cost of shipping to eastern markets. Speed is needed in harvesting so that the corms may be dug out of the ground before wet weather makes harvesting difficult. Also, if corms are dug too late in the fall, botrytis and fusarium fungi cause losses due to rot in storage. A gladiolus harvester would reduce the high labor costs and provide the speed necessary for successful harvesting.

The gladiolus acreage is limited, however, and a large number of machines will never be manufactured in any one year. Insofar as designing is concerned, this means that the parts must be built with a large factor of safety, as field testing cannot be extensive. Because of the limited number that probably would ever be made, the machine would not be mass produced. Parts would therefore have to be of standard types which could be procured locally. For this same reason, the design must be simple.

In 1950, the Oregon Agricultural Experiment Station undertook the development of a gladiolus harvester. Time was saved in designing by testing similar harvesting machinery. The department of agricultural engineering at Oregon State College, with the financial assistance of the Agricultural Engineering Research Foundation and the Northwest Gladiolus Growers' Association, borrowed an onion harvester that had been developed at the University of California. This machine was tested in 1950 in both the Portland and Corvallis areas of Oregon. The onion harvester was not satisfactory as a gladiolus harvester, but it did show the necessary requirements of such a machine. These tests saved several years of experimenting.

The first gladiolus harvester was built at Oregon State College during the summer of 1951 and was modified and field tested in 1951, 1952, and 1953. Trials were made on all types of soil and in both wet and dry weather. The machine was able to harvest, on an average, 1½ acres in a 10-hr day. There were few breakdowns, and the machine maintained a steady output of corms. On an average, about 11 percent of the corm tops were longer than one inch above the corms. Injuries, as a rule, were not higher than 1½ percent. Some corms were left in the field with the tops pulled off, although the percentage was not high. The amount depended upon the maturity of the corm, the variety, and certain fungi which were present and weakened the corm tops.

The power-transmission system, the hydraulic system, and the strength of the machine and parts were designed to carry the estimated loads of harvesting. The problem was complicated by three factors in particular: *(a)* the great contrasts between varieties as to thickness of stems, strength of tops, and shape of the corm, *(b)* variations in growers' practices as to depth of planting, row spacing, and number of corms to the row, and *(c)* soil types and percentage of moisture of the soil. After the machine was built, time was spent in experimenting to make it work satisfactorily. It is now felt that development has proceeded far enough to prepare a bulletin and make working drawings. Further improvements can be made from time to time from actual field trials of the machine.

The gladiolus harvester consists essentially of a lifter frame and a trailer frame (Fig. 1). The function of the lifter frame is to lift the gladiolus plant out of the ground, convey it to the rear of the machine, and cut the top off even with the top of the corm. The trailer frame supports the lifter frame and carries the operator and trays.

The Lifter Frame

The lifter frame, which is the heart of the machine, supports the digger blade in front and the stripper bar and cutter to the rear. In addition it carries the two large D-section V belts, which carry the gladiolus plants by their tops to the rear of the machine. The lifter frame is raised and lowered by means of two hydraulic cylinders. This motion places the digger blade in the ground.

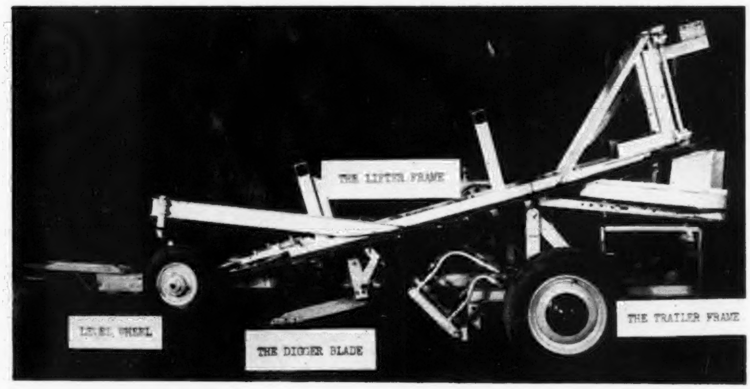


Fig. 1 The gladiolus harvester developed by Oregon agricultural engineers

Paper prepared expressly for AGRICULTURAL ENGINEERING. Approved as Technical Paper No. 847 by the Director of Oregon Agricultural Experiment Station, a contribution of the agricultural engineering department.

The authors—M. G. CROPSEY, R. N. LUNDE, and D. E. STAFFORD—are, respectively, associate professor agricultural engineering, professor of agricultural engineering, and formerly student in agricultural engineering, Oregon State College.

The Digger Blade

The function of the digger blade at the front of the lifter frame is to cut the roots of the gladiolus plant and lift it into position so that it can be grasped by the two V belts overhead (Fig. 2). When the machine is moving in a gladiolus row, the blade causes a layer of soil (with the gladiolus plant in it) to rise and pass to the rear of the machine. At the peak of the rise, the soil falls off the back of the blade, and at this point the gladiolus plant is grasped between the two D-section V belts. The location, therefore, of the digger blades with respect to the V belts overhead is critical. Placing the blade too far forward causes the gladiolus plant to fall off the back of the blade before it is grasped by the V belts. If, on the other hand, the blade is too far back, then the V belts tend to pull up the gladiolus plant before it is loosened from the ground.

The speed of the pickup belts is also critical. If the speed is too slow, too many plants tend to crowd between the belts at one time. If, on the other hand, the speed is too fast, the tops are torn loose from the corms below. Tests have indicated that a belt speed of about 1½ mph is about right when the machine travels at about ½ mph.

The slope of the digger blade is confined to narrow limits. When the machine operates in sandy or finely worked soils, a steep slope on the digger blade would push the soil forward, which in turn would push the gladiolus plant over to where it could not be picked up easily by the belts. To prevent the soil from being pushed forward, the slant of the digger blade is limited to about 20 deg with the horizontal. To raise the gladiolus plant from about 4½ in below the surface of the ground to the surface where it can be easily picked up, requires a blade about 16 in long. The blade was made 12 in wide to take care of crooked gladiolus rows and poor steering by the tractor operator.

A single support under the center of the blade is the most practical way to prevent weeds from accumulating on the support. At first the blade was held in position by a support on each side of the blade; however, the weeds collected across these two supports. After only a short distance down the gladiolus row, weeds would gather dirt which would push the gladiolus plants out of position so that they could not be picked up. On the other hand, a single support in the center of the blade can follow the break in the gladiolus row. The few weeds that gather on this single support tend to slide off on either side. Practically, this arrangement has proved most satisfactory in the field.

The Stripper

The stripper (Fig. 3) performs the function of cutting off the gladiolus tops even with the tops of the corms. As the gladiolus plant is conveyed to the rear by its top, the plant passes between two sets of stripper bars which are at an angle of 20° with the D-section V belts. The gladiolus plant is then pulled up until the top of the corm is brought against the stripper bars, which prevent it from rising higher, as shown in Fig. 3. Two C-section V belts on each side and above the stripper bars push the gladiolus plant through to the cutting blades in the rear. Pressure between the C-section V belt that conveys the gladiolus plant back into the cutter disks must be regulated so that the tops will slip up through them until the corms are in contact with the stripper bars. At

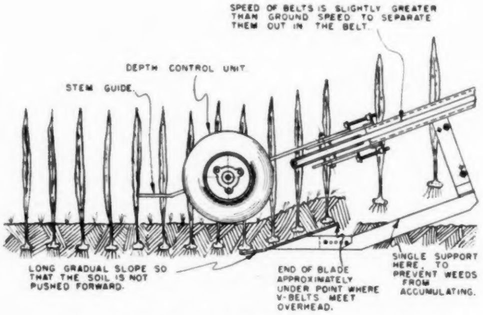


Fig. 2 The blade of the Oregon gladiolus digger

this point the D-section V belts must allow the gladiolus plant to slip down. Tests showed that the D-section belts must pull about six to seven pounds greater than the C-section belts below.

Two sets of stripper bars, one in front and one in the rear, limit the height to which the gladiolus plant can rise. They take care of any unevenness of planting depths or unevenness as to where the gladiolus tops are grasped by the V belts. These stripper bars are spring loaded. If a very large gladiolus top is between the bars, the sides of the bar can spread apart and allow it to pass to the rear. Likewise, for a very small gladiolus top, the sides can close around it to prevent its corm from slipping up between them. There were a number of difficulties encountered in the development of the stripper bars. The greatest difficulty occurred when a very small corm followed a very large corm. Sometimes the top of the larger corm would permit the smaller corm to slip up between the stripper bars. This was serious, as either the smaller corm was lost or it became crushed. Still more serious was the fact that these small corms actually could get under the C belt and force it off its pulley and stop the machine.

Two things were done to overcome this difficulty. Two sets of bars in tandem, one to the rear and one in front, tended to reduce the number of gladiolus plants in each set of bars at one time. This in turn tended to reduce the probability of having a small corm slip up between the bars because of a large top ahead of it. The second thing that was done was to raise the C belt about one inch above the stripper bars. This modification permitted a small corm that

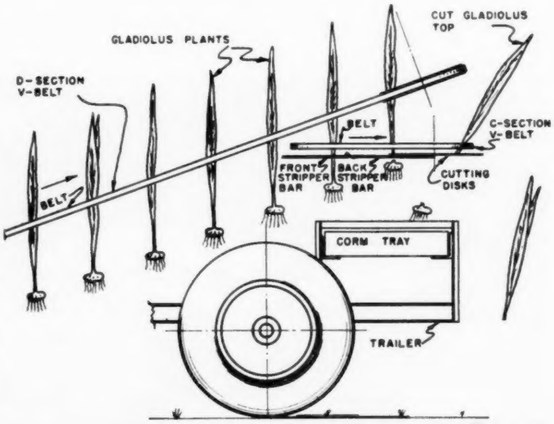


Fig. 3 The stripper and cutter disks

was pulled up above the bars to have a space to ride out behind the machine. This did not prevent loss of the corm, but it did prevent the C belt from jumping off. The loss of the small corms that slipped up between the bars was not large; in many cases they could be picked up later by hand. Differences in size of the average run of corms could also be taken care of by adjustment of the spring tension on the idlers of the D-section V belt overhead.

Position of Stripper Bars in Reference to Digger Blade

There is a relationship for best operation between the stripper bars in the rear and the digger blade in front as to their distances below the D-section V belts. The vertical distance between the stripper bars and overhead D-section V belts must be less than the space between the digger blade and these same belts. This requirement is necessary if the corms are to be caught by the stripper bars. If the belts grasp the top too close to the corm, then the corm will ride over the top of the stripper bars without being caught. Too much rubbing tends to injure the corm. Also, better results will be obtained if the length of time the corm rubbed against the stripper bars is a minimum. On the other hand, if the D-section V belts grasp the top too far above the corm, then the corm will not reach the stripper bars. As a result, a part of the top will remain on the corm. This is undesirable from the growers' point of view. For best results, the rear stripper bars at a point of 6 in from the disk blades should be 12 in below the D-section V belts when the back of the digger blade is 12 in below these same belts.

The Hydraulic System

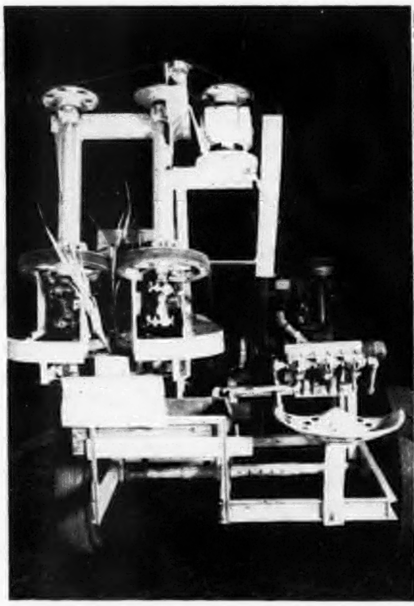
The hydraulic system elevates and lowers the lifter frame with its digging blades and stripper, so that the operator can regulate the depth of the blade over uneven ground and can lift the blade out of the ground when turning his machine at the ends of the rows. Stops are placed on the hydraulic cylinder so that the blade is limited to the maximum permissible depth at any one setting. A level wheel, which is placed even with the point of the digger blade, as shown in Fig. 2, indicates the depth of the digger blade. When harvesting over uneven ground, the operator can watch this level wheel and make slight adjustment in the hydraulic control to provide the ideal depth to operate. On flat, level land the machine can be set at the right depth at the beginning of a row and no further adjustment is needed.

The hydraulic system was of a selective type with a gear pump rated at 1,000 lb per sq in. There were two 8-in-stroke cylinders with one control valve. It was found, however, that this combination was too sensitive and the motion too rapid for small adjustments to be made by the operator. The pressure on the pump was reduced to 300 lb per sq in by changing the spring on the relief valve. Orifices were also placed in the hydraulic lines to the cylinders to retard flow.

The Power Transmission System

The power transmission system is illustrated in Fig. 4. Power to operate the machine is furnished by a 5 hp, air-cooled Briggs and Stratton engine. The center of the V-belt pulleys on the engine are aligned with the center of rotation of the lifter frame so that the tension on the belt will not change when the lifter frame changes positions. Two A-section V belts transmit power from the pulleys of the clutch on the motor to the gearbox on the lifter frame. The belt-pulley ratio between the engine and gearbox is 2½ : 1. Reduction in the gearbox is 11 : 1. A system of No. 60 roller chain and sprockets power the belt pulley in opposite directions. Two shafts lead down from the overhead sprockets to transmit power first to the large-section V belts and then through two sets of universal joints to the cutter disks and C-section V belts below. The system was designed to transmit 5 hp. Only one failure has occurred in its operation, when a 2-by-2-in stick was picked up by the belts and brought to the cutting disk in the rear. The disks were unable to cut the stick, and the two universal joints were snapped. This experience indicated the need for larger and heavier universal joints and for shear pins in these joints.

Power to the hydraulic system is continuous. It does not go through the clutch, but goes directly from engine to pump. This is necessary so that the hydraulic system will work when the V-belt pulleys are not in operation. For example, it is frequently necessary to raise or lower the lifter frame and digger blade when the belts are not in operation.



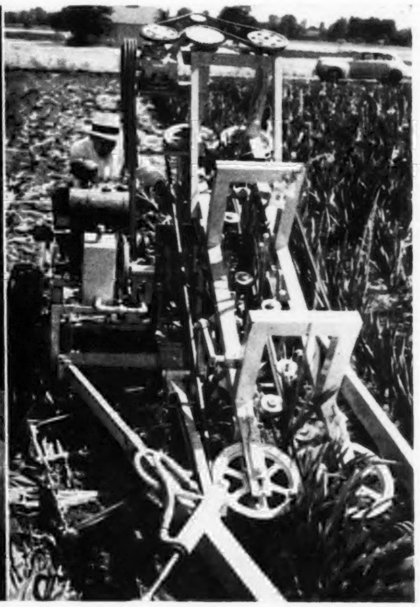


Fig. 4 *(Left)* The power transmission system as seen from the rear of the machine • Fig. 5 *(Right)* Front view of the gladiolus harvester in operation

Results and Limitations

The machine has harvested satisfactorily on the limited acreage on which it has been tested. Further field trials will undoubtedly show the need for additional modifications.

(Continued on page 573)

Peanut Curing as Related to Mechanization

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Member ASAE

Success of Artificial Drying Depends on Proper Curing

MECHANIZATION of harvesting of the Virginia-type peanut requires artificial drying and such drying is not successful without proper curing. Drying used in this sense implies only the removal of water, whereas curing refers to a chemical and/or physiological change within the peanut accompanied by water removal. In the Southwest large acreages of peanuts are harvested mechanically without artificial curing, but differences in time of year at which harvest is accomplished and in the rainfall, temperature, and humidity make complete windrow curing impossible in most of the Virginia-type peanut area. Although future research may divulge better curing techniques, sufficient evidence has been gathered to give approximate conditions required for good curing.

Results of Curing Studies

Since 1946, Georgia, Alabama, Texas, North Carolina and Virginia agricultural engineers, crop specialists, and physiologists, with the cooperation of similar specialists of the U.S. Department of Agriculture have made many studies of curing peanuts and have found that peanuts freshly dug from the ground and dried in a period of less than 96 hr often exhibit unusual flavors or lack of flavor and loose their seed coats with attendant splitting in the peanut mills. Chemical or physiological causes for "off flavors" and "skin slippage" of rapidly dried peanuts have not been discovered, but methods of reducing these factors of damage are partially defined. Baker, Cannon, and Batten[1] reported greater skin slippage when *(a)* the rate of drying was high, *(b)* the initial moisture content of the peanuts was high, and *(c)* the final moisture content of the peanuts was low. The last cause of slippage is more important than the other two. The same workers reported maximum palatability when peanuts are dried with air temperatures of 85 to 90 F. and air flows of 13 to 17 cfm per cubic feet of peanuts. However, if nuts are allowed to dry to 20 percent moisture content before placing them in the drying bin, temperatures up to 100 F did not seem to affect the flavor. Similar findings were reported by Teter[2] in that peanuts left in the windrow for a period of two to twelve days and then dried show as great or greater yields than stack cured. The shelling damage is comparable to stack cured (19.1 percent compared to 17.5 percent) and little taste differentiation is noted.

The best curing recommendations available at the present time consist of windrowing the peanuts until they are thoroughly wilted. Around Rocky Mount, N. C., peanuts are harvested in September and will be reduced to 25 percent moisture or below in about four days. However, in the vicinity of Holland, Va., harvest occurs in October and the average water content of peanuts windrowed 2, 4, 6, and 8 days was 44, 37, 31, and 30 percent, respectively. On the average over the Virginia-Carolina area, a 6-day windrowing time appears to give good results. After partial windrow curing, the peanuts can be dried either on the vine or off the vine. For best drying results the temperature should be between 80 and 90 F and the air flow between 10 and 20 cfm per cubic foot of peanuts. Drying should be discontinued when peanuts have a moisture of 12 to 9 percent.

The success of any system of mechanically harvesting peanuts depends in the final analysis on the net benefits derived by mechanization over the benefits derived by using the laborious hand-stacking methods now used. The overhead costs of the machinery and effects on quality must be considered along with the operating and overhead costs of drying to be balanced against the savings in labor, peanuts and time. Generally speaking, the longer the peanuts remain in the windrow, the less the water removal and consequently less operating cost is incurred in drying; and there is less danger of impairing quality by further rapid drying. For Holland, Va., conditions the following data were obtained:

WATER TO BE REMOVED TO OBTAIN 1 TON OF 8 PERCENT MOISTURE PEANUTS

Average 1952-53, Holland, Va.

Time in windrow	Pounds of water
0 days	2280
2 days	1410
4 days	1010
6 days	740
8 days	700

Therefore, power and fuel cost for drying peanuts which have lain in the windrow six days will be approximately one-third as great as that of drying freshly dug peanuts. At present prices, removal of 1,000 lb of water from peanuts will cost about $8 for fuel and electricity in the moisture ranges of from 20 to 10 percent. Power and fuel cost for drying windrowed peanuts will be $4 to $8 per ton compared to $16 per ton for freshly dug peanuts.

The overhead cost for drying will vary widely depending upon the use made of the drying equipment, the amount of new construction required, and the handling facilities available, so no reasonable dollar figure can be estimated. Picked peanuts will weigh approximately 12 lb per cu ft at 8 percent moisture, and the peanuts on the vine will occupy from 500 to 900 cu ft per acre depending upon the yield and lushness of vegetative growth. Peanut vines from one acre grown in a favorable season and receiving adequate sulphur dusting will occupy about 900 cu ft per acre when taken from the windrow and dumped with a hay fork onto a drying floor. These figures can be applied to the particular farm in question to determine the space requirements for design of a drying system, the details of which are of paramount

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[1]Baker, V. H., B. M. Cannon, and E. T. Batten, Peanut harvesting and drying research. *Peanut Jr. & Nut World*, vol. 31, November, p. 24-27, 56, 1951.

[2]Teter, N. C., Artificial curing of Virginia peanuts. Proceedings 49th annual convention of Assoc. Southern Agricultural Workers, p. 31, 1952.

importance in overhead cost. In making a logical design of a system, drying-time estimates are required. The following table may assist in estimating time for drying picked peanuts:

DRYING RATE OF PEANUTS BLOWN WITH AIR TEMPERATURES 20 F ABOVE AMBIENT

Average 7 Tests at Each Rate—October 19 to November 9, 1953

Rate of aeration, cfm/ft³	Drying rate, lb/100 lb dry matter/hr	Drying time, hr from 35 to 8%	Btu heat input per lb water removed
20	0.77	58	3,490
10	0.52	87	2,870
5	0.39	115	2,440

Excellent drying prediction formulas have been developed by Baker, Cannon, and Stanley[3]. When using a 20 F temperature rise, peanuts should not be over 3 ft deep on non-reversible air flow to avoid overdrying the bottom before the top is sufficiently dry.

A 5 to 6-day period should be allowed for drying peanuts on the vine in the Virginia-Carolina region. Under favorable windrowing conditions, this should give adequate time for unloading the preceding charge from the building and loading a new batch. Adverse conditions will require a full five-day period for drying.

Partially windrow-cured peanuts can be successfully dried with unheated air. The minimum allowable air volume required is not established, but air flows of 20 cfm per cu ft of peanuts gave results similar to those obtained with use of air temperatures into the bin of 105 F. After peanuts are lowered to 15 percent moisture with unheated air, operation should be intermittent; that is, the fan should be run only during clear days. The time of drying is increased over that required for drying with supplemental heat.

Methods of Obtaining Curing Results

The struggle to find a solution to the more efficient and proper curing of peanuts in this area has employed eleven different agricultural engineers part of the time during the 1946-53 period. They have supervised the construction of six different drying structures capable of handling peanuts both on and off the vines. Each of these major structures was capable of handling the peanut production from at least 25 acres of peanuts. Thirty-two small test bins with controlled heat and air flow have been employed in the attempt to establish the best temperatures and air flow for curing the peanut. Botanists, chemists, horticulturists, statisticians, and industrial laboratory workers have given assistance and advice regarding the methods of setting up experiments and furnished invaluable data on the test results. The Section of Vegetable Crops of the Horticultural Research Branch (USDA) analyzed samples from both Virginia and North Carolina for breakage and skin slippage in shelling, taste, germination, weather damage, and blanching characteristics, each year during the past six years. Industry responded to each request for aid. Planters Nut and Chocolate Company, Rosefield Packing Company, Greenville Peanut Company, Lummis and Company, and the Parker Peanut Company have all rendered assistance on the analysis of test peanuts obtained by artificial curing.

In the experimental period many ideas have been tried. Peanuts have been dried in temperatures from no heat to 130 F and with air flows of 1½ cfm per cu ft to 45 cfm per cu ft. Vacuum drying was explored. In attempts to find methods of drying freshly dug peanuts without injury, they were dried on the vine and off the vine, and with the vine clipped at various periods of time before they were dried. Freshly dug peanuts were soaked in water, refrigerated, treated with SO_2, treated with sodium hypochlorite, submitted to high humidities in drying and allowed to tray dry in the shade and in the sun. From some of these many experiments it appears that freshly dug peanuts can be cured to give a good product if drying is very slow. All such slow drying attempted in bulk of picked nuts has produced molds which ruin the quality of the peanut before they are cured. To date no practical method of artificially curing a freshly dug and picked Virginia-type peanut is known.

At the present time, the Upper Coastal Plain Experimental Farm at Rocky Mount, N. C., has drying facilities for handling the production of hay and nuts from about 30 acres of peanuts in four batches of 7½ acres each in the building. The Tidewater Field Station in Holland, Va., has a building capable of handling about two acres of hay and nuts per batch. Sixteen bins with controlled air flow to each bin and facilities for varying the heat input into each bin are located at Holland, Va. These facilities may be used in the future to refine the techniques of curing peanuts and in efforts to develop application of artificial peanut curing to farm operation.

Mechanization and Peanut Curing

Three paths are open to industrialists, farmers and agricultural leaders in the peanut harvest of the future. They may *(a)* continue to place peanuts on the stack pole, *(b)* windrow peanuts and use artificial curing to remove the water left after about six days in the windrow, or *(c)* continue research and development in the attempt to find a way to dig and pick peanuts in one operation and provide some now unknown method of producing good-quality peanuts from the freshly dug and picked stock. Of these three paths, windrowing appears most inviting. Much work remains to be done to make windrowing a safe, efficient and acceptable practice, but evidence suggests it has potentialities.

In stacking peanuts about 29 man-hours of labor is required per acre of peanuts for the entire harvesting process. Farm labor is becoming increasingly difficult to obtain, making it nearly impossible to maintain enough labor on the farm to take care of the peak labor demand of the peanut harvest season. The common practice of tapping the muscle power of children who should be in school and women who are needed to maintain a pleasant home undermines the community strength. Under present conditions, employment of temporary labor for peak labor demands is difficult and costly.

Soon after digging, conventionally harvested peanuts are placed about a vertical stick about 7 ft long placed 15 in in the soil and equipped with one or two cross bars nailed about 8 in above the ground level. Less than 50 lb of peanuts on the vine are placed around the stack pole and remain about the pole until dry enough to pick—about 4 to 8 weeks after stacking. Many of these peanuts are exposed to the weather and become discolored in poorly constructed stacks. Peanut millers like a good percentage of fancy handpick peanuts for sale as peanuts to be roasted in the shell, a product which is ruined by mold discolorations in poorly built stacks.

(Continued on page 573)

[3]Baker, V. H., B. M. Cannon, and J. M. Stanley. A continuous drying process for peanuts. AGRICULTURAL ENGINEERING, v. 3, No. 6, p. 351-356, June, 1952.

Pressures in Deep Grain Storage Structures

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Member ASAE Assoc. Member ASAE

Laboratory Studies of Pressures Resulting from Increases in Grain Moisture

TWO points which should be considered in the design of deep grain-storage structures are the lateral pressure against the sidewalls and the vertical load supported by the walls. To determine these values most designers use an equation developed by Janssen (9)* in 1895 as follows:

$$L=\frac{wR}{u'}\left(1-e^{-ku'y/R}\right)$$

in which L = unit lateral pressure at any elevation, pounds per square foot
u' = coefficient of friction of grain on the bin walls
w = unit weight grain, pounds per cubic foot
y = depth from top of bin to point under consideration, feet
k = ratio of lateral to vertical pressure
R = hydraulic radius = area of horizontal cross section of the bin divided by the perimeter
e = Naperian log base.

With the introduction of grain ventilation for the purpose of cooling or drying, or both, additional variables may be added that are not included in this equation. One of these is the increase in pressure due to the swelling of the grain which results from an increase in the moisture content of the grain. Another variable may be the decrease in pressure resulting from shrinkage of the grain as moisture content decreases. However, since this is a decrease in pressure it is not as structurally important as the other factor.

In general it has been found that, when drying high moisture grain with forced ventilation of natural air, more rapid drying is accomplished by allowing the fan to operate continuously, rather than during periods of low humidity only. However, during periods when the atmospheric relative humidity is higher than that in equilibrium with the drier grain in the bottom of the bin, the grain may increase in moisture content. Observations made during tests indicate that the pressures developed as grain rewets are quite large as evidenced by the difficulty in probing the grain and deformation of the structure. Also observations had been made of several grain bins that had failed during the flood of the Missouri River in 1952. Water entered the bin resulting in swelling of the grain and an increase in pressures large enough to burst the bin. Many bins failed as a result of this action.

With the above factors evident, work was begun to determine approximately what increases in pressure in grain bins could be expected from these phenomena. However, it soon became evident that to make any accurate determination of pressures in grain bins, it would be necessary to develop a method of measuring such pressures.

Development of a Pressure Cell

The pressure cell used in this work was developed after an extensive review of literature on pressure devices for soil, sand and grain. Although little previous work had been recorded where pressure cells had been used to measure the pressure of grain, the work with sand indicated a few of the more important characteristics required for a satisfactory pressure cell.

It was found that granular materials should have a relative large ratio between the diameter of the cell and the deflection during the measurement. This tends to minimize

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*Numbers in parentheses refer to the appended bibliography.

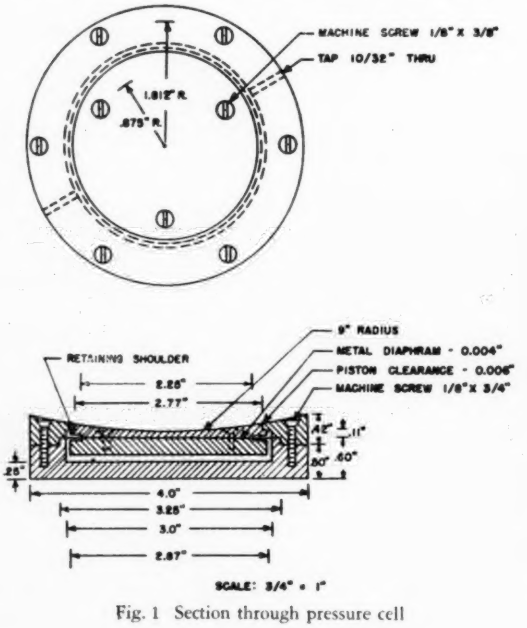


Fig. 1 Section through pressure cell

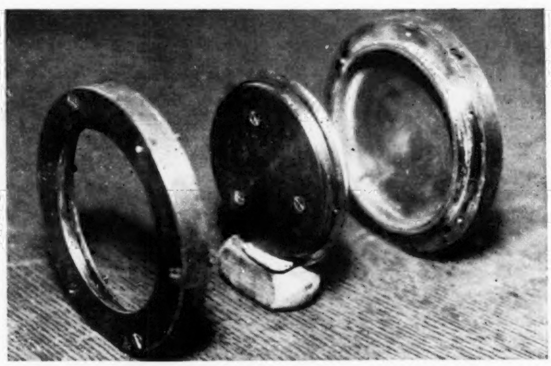
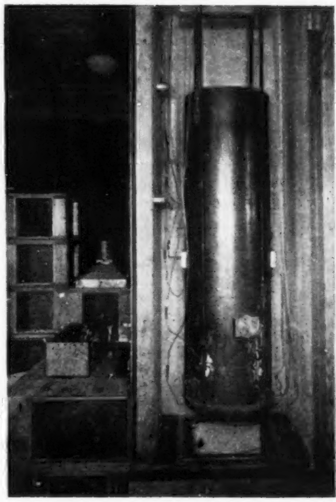


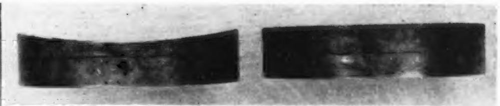
Fig. 2 An exploded view of the pressure cell showing the cylinder, diaphragm, and clamp

the effect of bridging of the material and will give more accurate pressure readings.

A line drawing of the cell, which was constructed of brass, is shown in Fig. 1. It consists of a cylindrical brass case with one open end, a movable piston fitted loosely in the open end of the case, and a thin brass diaphragm which holds the piston flush with the rim of the case. The diaphragm was clamped between two sections of the piston. The piston face was six square inches in area.

In this study the cell was mounted flush with the inner surface of the test bin. The pressure of the grain on the piston was counterbalanced with a sufficient head of oil to prevent movement of the piston during filling of the grain bin. To determine the pressure of the grain against the face of the piston, the head of oil was reduced until a slight movement of the water-oil interface in a transparent tube was apparent. The pressure against the piston face was, then, the head of oil multiplied by the specific weight of the oil. Since the face of the piston contained 6 sq in and the cross sectional area of the glass tube was 0.0069 sq in, movement of the piston was magnified 870 times in the glass tube. By limiting the movement of the water-oil level in the glass tube to 0.5 in, the piston movement was limited to a movement of approximately 0.0006 in. This gave a diameter deflection ratio of 4900 which is well within the allowable range as had been determined in sand-pressure experiments.





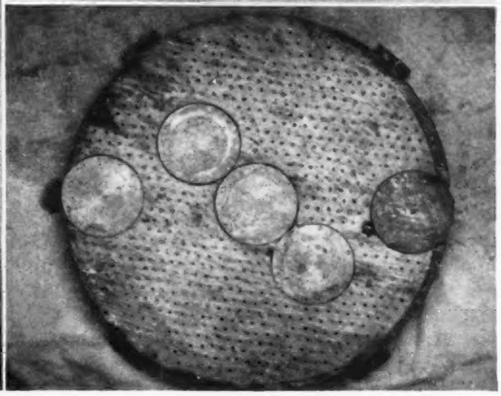


Fig. 3 *(Left)* Test bin and experimental setup used in the determination of deep-bin pressures of rewetting of corn • Fig. 4 *(Right, top)* Side view of pressure cell showing curvature used to fit inside surface of the test bin • Fig. 5 *(Right, bottom)* Arrangement of pressure cells in the floor of bin

Although the above method of pressure measurement did prove relatively satisfactory, there are several precautions that must be taken or else erroneous readings will result. They are: *(a)* All air must be bled from the cylinder, *(b)* all connections must be of a material which will prevent expansion, and *(c)* the cell must be almost perfectly machined.

In some of the tests, pressures were so high that it was necessary to devise a slightly different means for their measurement. In this case a column of mercury was used to counterbalance the pressure of the grain. Mercury could not be used in the cell because it reacts with brass. Water was used in the cell with a small glass bulb to contain the mercury just a few inches outside of the cell. An inclined capillary tube extended out of this bulb. When pressure was applied to the piston, water in the cell forced the mercury up the inclined capillary tube. The pressure in the piston was determined from the height of the column of mercury. Movement in the piston was magnified 19,000 times in the capillary tube. This method was entirely satisfactory; however, the above precautions are again needed.

Measurement of Pressures in the Test Bin

The test bin (Fig. 3), which was 5 ft high, was made of 14-gage sheet steel rolled to a diameter of 18 in. Pressure cells machined to fit the curvature of the bin (Fig. 4) were placed in a spiral around the bin at intervals of approximately 12 in vertically and 72 deg horizontally. Pressure cells were placed in the floor of the bin as shown in Fig. 5. The sides and floor of the bin were suspended separately by ⅜-in round rods. This allowed the sides and floor of the bin to be weighed separately with strain gages and thus served as a check against the pressure indicated by the cells mounted in the bottom of the bin. To obtain the required sensitivity the ⅜-in rods were cut and 0.01 x 0.5-in strips of shim stock were inserted lengthwise between the ends of the rods. Strain gages were mounted on both sides of each strip of shim stock. The gages were calibrated by loading the sides and floor respectively with dead weights.

Air-conditioning equipment was used to provide high humidity air to pass through the dry (14.0 percent wet basis) grain. With this equipment it was possible to obtain relative humidities of 83 percent. With air at this relative humidity, the moisture content of the corn could be raised to 17 percent wet basis.

Test No. 1

Four hundred and thirty pounds of corn at an initial moisture content of 14.0 percent was placed in the bin for the first test. The strain gages showed that 144 lb of corn

TABLE 1. SUMMARY OF TEST NO. 1 SHOWING WEIGHT TRANSFER FROM SIDES TO BOTTOM

Weight of corn put into test bin	430 lb
Initial moisture content of corn	14.00 percent
Final average moisture content of corn	15.4 percent

Hours operation	Weight supported by bottom of bin, lb	Weight of corn supported by test bin wall, lb
Initial	144	286
24	419	13
48	481	−42*
72	528	−89
96	537	−103

*The negative value indicates that the bottom is supporting all of the grain plus part of the weight of the steel bin.

were supported by the floor and 286 lb were supported by the sides. After 96 hr of operation, the entire weight of the corn plus the weight of the tank wall was transferred to the bottom. The pressure increased on the bottom from an average of 0.56 to 2.12 psi which was the maximum possible with the sides and floor supported separately. As a result of this test, the sides and floor were fastened rigidly together to simulate actual conditions.

Test No. 2

Four hundred and twenty-two pounds of corn at an initial moisture content of 13.0 percent was used for this test. Air at an average relative humidity of 78 percent was forced through the grain until no further increase in pressure was indicated by the pressure cells. The moisture content of the grain in the bin increased from 13.0 to 16.9 percent at the bottom and 13.4 percent at the top. The maximum lateral pressure recorded by the cells was 1.96 psi. The average bottom pressure was 2.2 psi. This is only slightly higher than the average pressure developed in test No. 1.

TABLE 2. SUMMARY OF TEST NO. 2

Weight of corn put into test bin	422 lb
Initial moisture content of corn (wet basis)	13.0 percent
Final average moisture content of corn	15.1 percent
Average relative humidity of air forced through corn	78 percent

Pressure cell readings, psi — **Bottom cells* (vertical pressure)**

Hours operation	1	2	3	4	5
Initial	0.54	0.57	0.67	0.54	0.57
24	0.86	1.05	0.64	1.12	0.88
48	1.76	1.90	1.50	2.12	2.07
72	1.93	2.10	1.54	2.36	2.03
96	1.96	2.29	1.54	2.66	2.12
120	1.96	2.56	1.56	2.80	2.03

Side cells† (lateral pressure)

Hours operation	1	2	3	4	5	6
Initial	0.31	0.21	0.17	0.17	0.11	0.03
24	0.36	0.69	0.44	0.49	0.17	0.01
48	1.84	1.09	0.61	0.70	0.29	0.01
72	1.93	1.50	0.77	0.90	0.35	0.01
96	1.93	1.50	0.97	0.97	0.54	0.03
120	1.96	1.50	0.84	0.87	0.50	0.03

*Cell Nos. 1 and 5 were at bin wall.
†Cell No. 1 was the bottom cell.

Test No. 3

This test was a duplicate of test No. 2 and the results were practically the same. The maximum lateral pressure was 2.00 psi, while the average vertical pressure was 2.04 psi. Based on test No. 1 this appears to be slightly low. The results of tests 2 and 3 are shown in Fig. 6 and are contrasted to computations for the same bin using Janssen's formula.

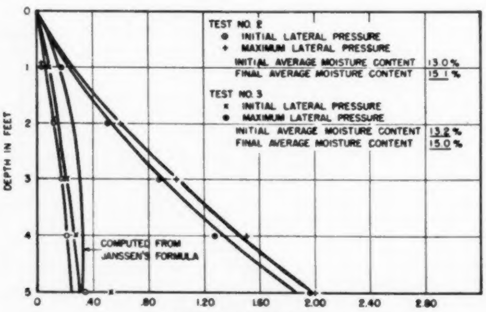


Fig. 6 Pressure increase with increase in grain moisture content

TABLE 3. SUMMARY OF TEST NO. 3

Weight of corn put into test bin	417 lb
Initial moisture content of grain (wet basis)	13.2 percent
Final average moisture content of corn	15.0 percent
Average relative humidity of air forced through corn	78 percent

Pressure cell readings, psi — **Bottom cells* (vertical pressure)**

Hours operation	1	2	3	4	5
Initial	0.45	0.58	0.70	0.55	0.52
23	1.15	1.08	1.33	1.03	1.20
48	1.86	2.00	1.74	1.93	2.00
72	2.00	2.05	1.93	2.11	2.05
96	—	—	—	—	—
120	2.00	2.11	1.93	2.11	2.05

Side cells† (lateral pressure)

Hours operation	1	2	3	4	5	6
Initial	0 52	0.28	0.20	0.21	0.12	0 02
24	1.03	0.80	0.34	0.40	0.27	0 09
48	1.86	1.20	0.94	0.87	0.37	0.02
72	2.00	1.26	1.00	1.00	0.47	0.10
96	—	—	—	—	—	—
120	2.00	1.26	1.00	1.00	0.60	0.17

*Cell Nos. 1 and 5 were at bin wall.
†Cell No. 1 was the bottom cell.

Test No. 4

This test was run to obtain some indication of the pressures developed in grain bins when corn is subjected to flood conditions. Four hundred and fifteen pounds of corn

TABLE 4. SUMMARY OF TEST NO. 4

Weight of corn put into test bin	415 lb
Initial moisture content of grain	12.5 percent
Final moisture content of grain	22.4 percent

Maximum pressure cell readings, psi* — **Bottom cells (vertical pressure)**

Hours operation	1	2	3	4‡	5
2	2.54	2.69	2.95	—	—

Side cells† (lateral pressure)

Hours operation	1	2	3	4	5	6
2	3.18	2.63	2.27	2.27	1.67	0.60

*Cell Nos. 1 and 5 were at bin wall.
†Cell No. 1 was the bottom cell.
‡Cell Nos. 4 and 5 were not recording.

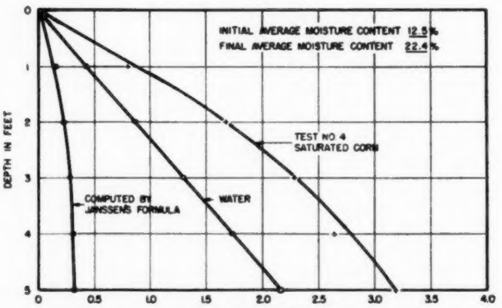


Fig. 7 Relative pressures developed by dry grain, water and saturated corn

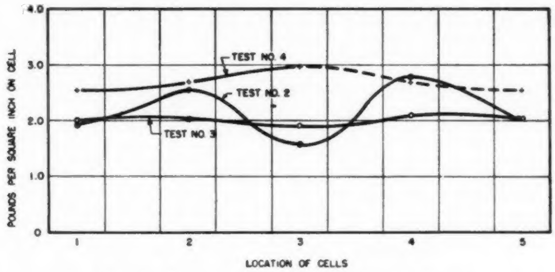


Fig. 8 Pressure distribution on floor bottom

at 12.5 percent moisture was completely covered with water for a period of about ten minutes; the excess water was then drained from the bin. The maximum pressures were developed in approximately two hours. Fig. 7 shows the lateral pressures which were developed as a result of this flooding. The maximum lateral pressure was approximately ten times the pressure of dry grain at that depth as calculated by Janssen's formula.

Fig. 8 shows the vertical load on the floor of the grain bin during the various tests. The total vertical load on the floor of the grain bin was not uniformly distributed. The pressure was least near the walls and increased toward the center of the bin in test No. 4 but the reverse was true in tests Nos. 2 and 3. No explanation was found for this.

CONCLUSIONS

The study reported in this paper has led to the following general conclusions:

1 Increases in the moisture content of stored corn from 1 to 4 percent during ventilation produced stresses in the sidewalls of a "deep" bin at least six times that of dry grain.

2 An increase in the moisture content of ten percent by flooding will develop pressures as high as ten times that of dry grain.

3 As the pressure increases due to swelling, the pressure distribution on the sidewalls approaches a straight line similar to that of a liquid.

4 To obtain a high degree of accuracy with the pressure cell it is very important that the compressibility of the cell be controlled. All air must be eliminated from the cell and all connections must be made of rigid materials.

5 Where grains increase in moisture content, Janssen's equation is not sufficiently accurate for computing lateral pressures.

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Machine Harvests Gladiolus Corms

(Continued from page 567)

There are limitations as to the variations in planting that the machine can harvest. The corms should be planted approximately the same depth, in straight rows, and not too many gladiolus bunched together in the same row. Failure to observe these rules will result in many injured corms left in the field and corms with long tops.

The large turning radius at the end of the rows is a handicap. Further research undoubtedly would result in a tractor-mounted harvester that would reduce the area of end rows to a minimum.

Peanut Curing Mechanization

(Continued from page 569)

By picking partially cured peanuts from the windrow and finishing curing artificially, no extra farm labor is required, weather damage and damage from birds and rodents is reduced, the over-all cost of operation may be cheaper, the possibility of producing high-quality hay is increased, and the peanuts have a brighter external appearance. The taste and tendency to skin and split in the mill may be slightly different from those of the stack pole peanuts now produced. However, this difference in quality can probably be kept to a level that is not serious.

The outlook for production of good quality peanuts at a reasonable cost by digging and picking in one operation is now poor. Peanuts dried artificially from moisture contents of 50 to 60 percent will have to be dried rapidly and will show a serious drop in quality, and operating costs of curing will be three times as great as for those from partially cured windrows. Furthermore, the artificial curing time will be longer than that required for windrowed peanuts making the overhead costs greater than those for windrowed peanuts.

Integration of Dairy-Processing Equipment

Carl W. Hall
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Desirable Performance Depends on Efficient Utilization of Labor and Equipment

THE margin of profit or loss in the operation of a dairy plant is frequently the result of care or carelessness in the selection of size, type, and arrangement of equipment. This paper is based on a study of 12 plants in central and southern Michigan in 1952 in which the entire plant operation was studied. The study of receiving-room operations was reported previously (1).* Charts have been published which present the cost of operation of various sizes of equipment for different volumes of plants from 20,000 to 100,000 lb per day (2).

The equipment from the receiving tank to the storage tank should be selected on the basis of the speed of the receiving-room operation. The equipment from the storage tank to the bottler should be selected on the basis of the speed of the bottling or processing operation to completely utilize the time of the workers.

The cleaning time used for calculating the cost of operation is based on an entirely manual-cleaning operation, that is, without circulatory methods, unless otherwise stated. Manual cleaning is done once a week when the cleaning is done daily with circulatory methods.

Clarifier

The clarifier may be placed between the receiving tank and the storage tank so that the sediment is removed from the cold milk as it is brought into the plant. The clarifier is usually placed in or near the receiving room. The largest clarifier generally used in the dairy plant has a capacity of 20,000 lb per hr. The capacity of a clarifier is regulated by a positive displacement pump placed between the receiving tank and the clarifier. With an average of 60 lb of milk per can dumping at a rate of 7.1 cans per minute, which is the optimum dumping rate for a one-man manual receiving operation, a 25,560-lb-per-hr clarifier would be required. The optimum rate of dumping is restricted in some plants by a small clarifier. This is not a serious matter from a labor standpoint in a dairy handling less than 80,000 lb per day. The milk lost from running the receiving tank over because of a small clarifier is more important than the loss of labor efficiency. It takes only 35 lb of unprocessed milk to pay for an hour of labor. The value of the wasted unprocessed milk is often overlooked by the worker and management.

The clarifier may be placed between the homogenizer and the storage tank to clarify the milk going to the pasteurizer. The operation preceding or following the clarifier should not be delayed by an undersized unit. On this basis, the small clarifier with a capacity of 5,000 lb per hr is most economical for dairies handling up to 50,000 lb per day. The medium-size clarifier with a capacity of 12,000 lb per hr is the most economical for dairies with a daily capacity of from 50,000 to 90,000 lb. For large dairies with a capacity above 90,000 lb per day, the 20,000-lb-per-hr clarifier is the most economical.

In the receiving room where a clarifier which is too small is penalized because of labor inefficiency for delaying the operation, the total cost of clarifying the milk would be less for a clarifier with a capacity up to about 25,000 lb per hr. This is based on a projected estimated cost of a larger clarifier, which is not commonly available commercially.

Filter

The total cost of filtering is about one-half as expensive as clarifying. The initial cost of a filter is about one-sixth as much as a clarifier. However, a clarifier is considered to do a better job of removal of sediment. A filter may be obtained in capacities up to 30,000 lb per hr and would not retard the one-man receiving operation. The cost of filtering also includes the cost of a positive pump and motor. The milk should be filtered while cold so that little of the sediment is dissolved in the milk.

Raw Milk Plate Cooler

When an unrefrigerated insulated tank is used for storage, the milk is first cooled to 40 F or below before going into storage, often with a plate cooler. The number of plates in the cooler can easily be changed, which gives it great flexibility. This cooling is usually done with sweet water although direct-expansion refrigeration can be used. It is usually not necessary to cool the milk through more than 10 F.

The total and unit costs of operation of the raw milk cooler for a one-man continuous receiving operation do not vary greatly as the capacity of the cooler goes above 20,000 lb per hr for various amounts of daily usage. There is little difference in the total cost of operation for either a 10,000 or 20,000-lb-per-hr plate cooler for a 20,000-lb-per-day dairy. For dairies with capacities ranging between 20,000 and 100,000 lb per day, the 20,000-lb-per-hr cooler is the most economical for a one-man receiving operation, even though the worker dumping milk is slowed down slightly.

Storage Tank

There are three general types of storage tanks: the insulated, the cold wall, and the insulated tank with expansion coils placed in the milk in the tank. The storage tanks can also be classified into vertical and horizontal tanks, usually cylindrical in shape.

There is little difference in the total cost of operation between the cold-wall refrigerated tank and the storage tank with direct-expansion refrigeration coils. The cost of using the insulated tank and the plate cooler is approximately 1.2 times greater than the cold-wall refrigerated tank for sizes above 2,500 gal.

The small 600-gal storage tank required more time for cleaning than the 1,000-gal tank. The variation is attributed to the difference in diameter of the tanks which affects the ease of cleaning. The 3,000-gal storage tanks are manufactured in 84-in and 96-in diameters, both selling for the

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*Numbers in parentheses refer to the appended bibliography.

same price. All tanks above 3,000 gal have a diameter of 96 in. The 84-in-diam 3,000-gal tank required 5 min less cleaning time per day than the 96-in-diam tank. These figures apply to workers who are between 5 ft 8 in and 5 ft 11 in in height. The 600-gal storage tank has a diameter of 56 in.

The times recorded for cleaning the tank were taken from personnel using their own and sometimes inefficient methods. By using a cleaning brush with a long handle and an improved technique for cleaning, it may be possible to clean the large diameter tanks as rapidly as the medium diameter tanks.

The vertical cylindrical storage tank offers a potential saving of floor area. A few dairy plants are using vertical storage tanks with capacities over 2,000 gal. The daily cleaning time saved for the 2,000-gal vertical tank with either bottom or top opening was 4 min. In plants where both horizontal and vertical storages of 2,000-gal capacity were used, the workers favored the vertical storage. Adequate room ceiling height must be available for the large vertical storage.

Internal Tube Heater

Prior to separation, milk is usually heated to 90 F or above with an internal-tube heater. If the milk is to be vat-pasteurized, it may be heated to 140 F. For a 10,000-lb-per-hr internal-tube heater the cost per 100 lb of milk is 2.8¢ to 2.3¢ for heating 10,000 and 40,000 lb of milk per day, respectively. This is based on heating from 40 to 90 F with a steam-heating efficiency of 75 percent. The unit cost does not vary greatly for the amount of milk handled.

Separator

The 3,500-lb-per-hr warm milk separator is the most economical for volumes up to 15,000 lb per day. The 7,000-lb-per-hr separator is the most economical for from 20,000 to 40,000 lb per day. The 11,000-lb-per-hr separator is most economical for volumes above 40,000 lb per day.

Cold milk separation is gradually coming into use because of the development of the airtight separator. The capacity of the cold-milk separator at 40 F is approximately 55 percent of its capacity at 90 F. The problems involved with the auxiliary equipment such as heating, cooling, and piping as well as floor-space requirements are considerably less for the cold-milk separator. For cold-milk separation, the 2,000-lb-per-hr unit is the most economical for volumes up to 10,000 lb per day. The 4,000-lb-per-hr cold-milk unit is most economical for from 10,000 to 20,000 lb per day separation. For separating quantities above 20,000 lb per day the 6,000-lb-per-hr unit is most economical. The small 3,500-lb-per-hr separator requires ¾ hr for cleaning while the larger 11,000-lb-per-hr unit requires ⅞ hr for cleaning.

Homogenizer

In the continuous process using the high-temperature short-time method of pasteurization, the milk is heated, then it is homogenized at a temperature between 130 and 145 F. The milk then goes to the plate heaters for pasteurization.

Thirty minutes are required for cleaning the 500-gal-per-hr unit and 40 min for cleaning the 2,000-gal-per-hr unit. Approximately 32 percent of the cleaning time was devoted to assembling the unit. The cost of homogenization is important because many dairies charge an extra cent per quart for homogenized milk. The cost per 100 lb is 1.1¢, 5¢, and 9.5¢ for an 80,000, 10,000, and 5,000-lb-per-day processing operation, respectively.

High-Temperature Short-Time Pasteurization (HTST)

The HTST pasteurization process consists of heating the milk to not lower than 160 F, holding for 15 sec, and immediately cooling to 50 F or lower. In actual practice the milk is heated to a temperature of from 160 to 163 F. The heating and cooling operations are carried out in a plate unit similar to the plate heater with appropriate controls. One of the major benefits of the HTST method of pasteurization is the ease in which regeneration can be done.

The question is often raised as to how small a dairy can justify purchasing an HTST unit. Even if regeneration is used with the holding process, the HTST method is less expensive for a dairy as small as 8,000 lb per day. The HTST unit should be large enough to supply milk to the bottle filler rapidly enough to keep the men fully occupied.

Glass Filling and Capping

The bottling operation is used as the basis for planning the operations from the storage tank to the refrigerated bottled milk storage. The selection of a bottler of the correct capacity for present and future use should receive special consideration.

Individual glass fillers are made so they can be adjusted for a wide range of speeds. The change of speed is a necessity when changing size of milk containers while using a continuous pasteurizer.

It is very difficult to estimate the running capacity of the filler because of the variations of products, cleaning time for different products, bottle sizes and filler sizes in different plants. Most fillers operate at less than 90 percent of the rated capacity. One man can inspect and case quart bottles at the rate of 63 bottles per minute and half pints at 99 bottles per minute. These are the maximum speeds at which a person can be expected to perform.

If a bottler is operating at 90 quart bottles per minute, two men would be required to inspect and case the bottles in an operation where only 1.5 men would be utilized. It would be difficult to utilize fully the work capacity of these two men by other productive labor, unless another bottling or carton machine was feeding into the same table. The filler should run at 60 bottles per minute for one man or 120 bottles per minute for two men.

The bottling operation is the most expensive of all those involved in milk processing. Methods are constantly being improved to reduce the cost of bottling. The bottle is a major item of cost and emphasis should be placed on increasing its life. Dairies can work together in recovering each other's bottles through a bottle exchange. Employees should be trained to handle the bottle with care to lengthen its life. A saving in the cost of operation of 5¢ per 100 lb of milk can be realized by increasing the number of trips per bottle from 25 to 50. This saving is greater than the total cost of such operations as clarifying, cooling the raw milk, storing, and homogenizing the milk.

The bottle cap is almost as expensive as the bottle. Many plants not only cap but also hood the bottles to prevent contaminating materials from collecting on the cap.

(Continued on page 578)

Power Units for Irrigation

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Physical and Economic Factors to Be Considered in Their Selection

THE high efficiency and low maintenance costs of centrifugal pumps make them ideal for use in pumping for irrigation, but unless discretion is used in matching the pumps with correct power units a great deal of power and/or money can be wasted.

Among the most important factors to be considered when selecting a power unit are *(a)* the physical and environmental factors in the area to be irrigated, *(b)* a comparison of the operating characteristics of the individual power unit with the operating characteristics of the pump, and *(c)* the comparative economy of the units under consideration.

The discussion of power units in this paper will be limited to electric motors, gasoline engines, and diesel engines. Although gas might be used in some areas, its use is not as widespread as the others.

Physical and Environmental Factors

Some of the physical and environmental factors requiring attention are as follows:

1 The number and accessibility of pump setups contemplated. Portable gasoline and diesel engines can be set up at any convenient spot so long as they are within suction reach of the water for centrifugal pumps. For deep-well pumps, locations would be limited by the well rather than the source of power. The chief restrictions in locating gasoline and diesel-powered units are those of accessibility from the standpoint of getting the equipment in place and the convenience of hauling fuel to the engine.

Where several setups are required, especially if they are widespread, the use of electric motors would be handicapped. Usually electric service organizations sell electricity to the farmer at regular rates delivered to a central service point, located near the center of the homestead. The farmer is then responsible for running the lines needed on the farm; consequently an irrigation system with a multiple-pump setup would result in the necessity of several lines across his farm. This alone in some instances would rule out electricity for power, especially if one or more are long lines. In other cases, where one or two convenient pump stations are required, electricity could be used quite satisfactorily.

2 Availability of fuel and electricity. In practically all areas gasoline and diesel fuels are available and will be delivered to the farm by distributors in quantities requested. Likewise, most rural areas in the Southeast now have single-phase electric current available but do not have three-phase current. Consequently electric-motor installations would in general be limited to 7½ hp or less. On some lines the new capacitor-start, capacitor-run motor is approved up to 10 hp on single-phase current. Even so, unless high pressures were essential, up to 25 acres could be satisfactorily irrigated with one 7½-hp installation properly designed.

3 As to the size of unit needed, the choice of a power unit may often be limited, depending on the horsepower needed to do the job. Power required for a specific job is directly proportional to the rate of flow and the total pumping head. Generally the choice would be as follows:

Up to 7½ hp—gasoline or electricity
7½ to 40 hp—gasoline (or electricity if three-phase current is available)
40 hp and above—gasoline or diesel

4 In the matter of relative initial costs of various units, on many farms there may be available an old engine not useful for other purposes which could be repaired and used to power an irrigation pump. On other farms a large farm tractor which is used primarily for preparation cropland might be made available for pumping when needed, although caution should be used before tying up an expensive tractor for pumping water. In both cases the initial cost of a new unit would be avoided, resulting in a smaller outlay of cash for the irrigation system. There are also other instances where farmers have been able to buy secondhand gasoline, diesel, or electric-power units at a very reasonable price. All of these factors should be considered carefully before a final decision is made.

Operating Characteristics of Internal-Combustion Engines

Internal-combustion engines will give long and satisfactory service if manufacturers' recommendations are followed. Unfortunately engines are frequently operated beyond their most efficient range, some of the reasons for which are as follows:

1 Pump and power unit may not be correctly matched. Frequently in engine-pump combinations the most efficient speed of the pump and the rated speed of the engine do not

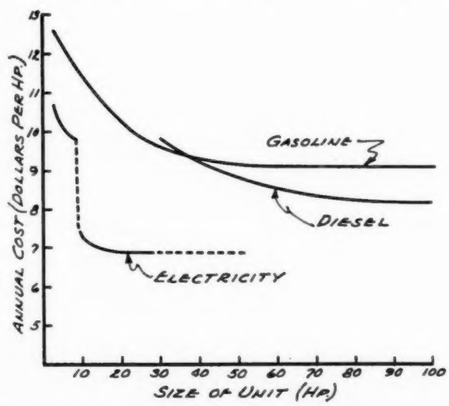

Fig. 1 Cost comparisons for power units based on 360 hr of operation per year, including initial and fuel costs and excluding lubrication, maintenance, repairs, and intangible costs

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coincide. All centrifugal pumps have certain speeds at which they reach maximum efficiency, which is usually approached rapidly as speed increases and drops off rapidly as speed is increased beyond the most efficient range. Gasoline engines normally operate most efficiently at 70 to 85 percent of maximum output. If 70 percent of maximum output can be obtained at the same speed which gives maximum efficiency of the pump, it would result in a well-matched unit. In our studies at the North Carolina Agricultural Experiment Station, we use 70 percent allowing 20 percent reserve power and a 10 percent power loss over a period of years due to normal wear. Engines and pumps should be matched on performance expected several years hence rather than on performance while new. As an example, suppose a gasoline engine which delivers a maximum of 30 hp at 3,000 rpm is directly connected to a pump requiring 28 to 30 hp at 3,000 rpm for best efficiency. Should the engine operate at 3,000 rpm delivering 28 to 30 hp, chances of long life and good service are poor. On the other hand, if the engine was cut back to 2,100 rpm requiring 20 to 22 hp, poor pump efficiency would result. With the same engine a pump with highest efficiency at the above figures would result in the most economical unit over a long period of operation.

Engine-pump units assembled by pump manufacturers are usually well matched, although some variations can be found between manufacturers. The source of most trouble is the on-the-farm matching of farm tractors or old farm engines with centrifugal pumps.

2 Frequently competition between irrigation equipment salesmen causes them to sell units too small for long-term efficient operation in the interest of quoting lower prices to make a sale. This combined with a lack of knowledge concerning engine and pump operation is responsible for many installations where engines have to be run near or at full power to supply water at rates and pressures required in the irrigation plan. Regardless of make, engines on such installations cannot withstand the "beating" imposed upon them. For example, one installation in North Carolina was made in August, 1953. The pump was required to deliver 1,000 gpm at 110 psi, and to do that required near full power output of the gasoline engine. After six weeks of operation, repairs included three sets of spark plugs and breaker points, a new set of valve lifters, and other minor repairs. It was a constant nuisance to keep the engine running. Contrastingly, another pump on a different setup has operated at about 70 percent full power near Raleigh for five years requiring nothing more than regular maintenance and showing only normal wear.

Perhaps it would be advantageous for engine manufacturers to rate gasoline engines according to the type and severity of load. A gasoline engine on a farm tractor operating normally at 60 to 80 percent of maximum output would not be hurt severely if required to occasionally operate at maximum output. That type load is intermittent and gives opportunities for cooling.

3 Characteristics of centrifugal pumps are such that a considerable amount of power can be wasted if discretion is not used in setting the throttle on the engine. If an internal-combustion engine is selected to operate at 70 to 75 percent maximum power, a promiscuous opening of the throttle would result in only a slight increase in pump performance but a considerable increase in power consumption.

For trouble-free efficient operation of internal-combustion engines, a periodic maintenance schedule is a necessity.

Operating Characteristics of Electric Motors

If adequately sheltered from weather, animals, and insects, an electric motor can supply power conveniently and economically with an expected trouble-free life of 20 to 30 years. Contrary to the belief of many people, electric motors can be operated from no load to full load without damaging them. Among their advantages are the following:

1 Ease of operation—controlled by opening and closing an electric switch, or remote control if desirable
2 Low maintenance requirements
3 More dependable than engines
4 Long life expectancy
5 Delivers full power throughout its life
6 No danger of freezing (does not exclude pump from possibility of freezing)
7 No refueling.

Following are some of the disadvantages of electric motors:

1 Electric line must be run to every pumping station
2 Limited to 7½ hp or less on single-phase lines
3 Since speeds are not variable on electric motors, one of the three following methods will need to be used to control line pressures: *(a)* a belt drive with possibility of exchanging pulleys to regulate speed; *(b)* a by-pass or relief valve in the main line near the pump, or *(c)* a main-line flow-control valve near the pump.

A Partial Economic Comparison of Various Power Units

A comparison of the initial and operating costs of gasoline engines and electric motors is shown in Table 1. The figures are based on a 10-year life for the gasoline engine and a 20-year life for the electric motor. The 360 hr operation is assumed to be the average use per year in North Carolina. The figure would be smaller for some crops and larger for others. Fuel consumption data were obtained from manufacturers' literature and from the Nebraska Tractor Tests data. The use of electricity by electric motors was figured on a flat rate of 1 kw-hr per hp-hr output which is in most cases excessive of actual use.

This table does not include such costs as maintenance and repairs, convenience in op-

TABLE 1. COMPARISON OF INITIAL AND OPERATING COSTS OF GASOLINE ENGINES AND ELECTRIC MOTORS FOR IRRIGATION

	Electric motor			Gasoline engine		
Hp	Initial cost	Operating cost, 360 hr at 1.5c per kw-hr	Total cost per year, 20-yr life	Initial cost	Operating cost 360 hr at 19c per gal	Total cost per year, 10-yr life
3	$199.00	$ 15.75	$ 31.70	$ 80.00	$ 27.36*	$ 37.76
5	297.00	27.00	50.56	115.00	47.88	61.80
7½	420.00	40.50	74.10	150.00	68.40	87.90
10	232.00	54.00	72.56†	225.00	85.50	114.75
15	270.00	81.00	102.60	325.00	123.12	165.37
20	367.00	108.00	138.00	400.00	160.87	202.87
25	470.00	135.00	172.60	550.00	180.00	251.50

*Maintenance costs not included.
†Three-phase current needed; demand charge might increase operating costs.

TABLE 2. COMPARISON OF INITIAL AND OPERATING COSTS OF GASOLINE AND DIESEL ENGINES

Hp	Fuel per hour gal. Gasoline	Diesel fuel	For 360 hr Cost gasoline	Cost diesel fuel	Gas engine	Initial cost Diesel engine	Diff.	Saving in fuel, 10 years
30	2.73	2.08	$187	$112	$ 750	$1400	$ 650	$ 750
40	3.64	2.78	249	150	950	1700	750	950
50	4.55	3.47	311	187	1150	2000	850	1240
60	5.45	4.17	372	223	1325	2200	875	1490
70	6.36	4.85	434	262	1500	2400	900	1720
80	7.27	5.55	497	300	1800	2800	1000	1970
90	8.18	6.25	560	337	2000	3100	1100	2230
100	9.10	6.95	623	375	2200	3400	1200	2480

erating the units, and the construction of a power line to the pumping station. In some cases the actual costs of maintaining a gasoline engine and the cost of constructing an electric line would balance out.

In Table 2 is shown the initial and operating costs of gasoline and diesel engines, ranging in size from 30 to 100 hp. All fuel-consumption figures are based on actual consumption as shown by the Nebraska Tractor Test reports. As before, maintenance and repairs are not shown in the table, but it is assumed here that they would be about the same for the two units.

A summary of the economic analysis, based on conditions mentioned above, is shown in Fig. 1. As can be readily seen, with existing rates for electricity in North Carolina, it would be cheaper in the long run to use electric motors where possible to do so. Not only does it show to be more economical, but is much more convenient than gasoline engines. After the installation, which is usually more time consuming and more expensive than gasoline engines, the electric motors are practically trouble free, requiring no preventive maintenance, no oil changes, no refueling and no failure to start as is encountered with gasoline engines.

A look at the relative costs of gasoline and diesel engines shows that the lines cross at about the 40-hp mark, but that is not the complete story. The graph is based on 360 hr operation per year. If the running time averages less, then the diesel would become more economical somewhere above the 40-hp mark. If the operating time was more, then the diesel would become more economical below 40 hp.

Also, if an engine is to be abused, one stands a chance of losing more money in a diesel than in a gasoline engine. Only where adequate maintenance combined with proper care and operation are used would a diesel be advisable in preference to a gasoline engine, especially in the 40 to 60-hp range.

Dairy Processing Equipment

(Continued from page 575)

If the bottles are to be hooded it would seem logical to select a hood which would suffice to serve as a cap as well, thus eliminating an operation. Faulty hooding and capping operations account for practically all delays at the bottler.

Paper Carton Former and Filler

Only two major companies are manufacturing carton fillers in capacities ranging from 20 to 115 cartons per minute.

The cost of the paper carton forming and filling machine operation can be compared to the entire bottling cost which includes filling, capping, hooding and washing of the bottle. The paper carton operation of one of the major manufacturers costs approximately 54¢ more per 100 lb of milk than the glass-bottle filling and washing operations in the plant. Delivery costs are not included. The difference in cost has been realized by the dairies and has resulted in a charge of an extra cent a quart for milk in the paper carton in many areas.

Usually an attempt is made to reduce the cost of operation by replacing a series of operations with one operation. In the case of a paper filler, production costs have increased and the item has stayed on the market because of customer acceptance in spite of a higher price and lower delivery-route costs. The higher cost of operation is attributed to the fact that the single-service paper containers whose initial cost is less than glass bottles makes only one trip.

Glass Bottle Washing

Practically all plants use a soaker-type bottle washer which immerses the bottles in a strong alkali solution for about 15 min. For units of 100 bottles per minute capacity, the cost per 100 lb of milk varies from 8 to 15¢ for 100,000-lb and 20,000-lb-per-day capacities, respectively.

One man using efficient methods can place 100-qt bottles per minute into the bottle washer. In order to do this, a washer of a width in multiples of four bottles is most satisfactory because four bottles are handled at one time.

Refrigerated Bottle and Case Storage

The possibility for reducing the labor requirement in the cooler is excellent. The milk should be stacked for easy loadout. The cases should first be stacked away from the conveyor and then stacked between the conveyor and the stacked cases. A conveyor placed parallel to the long axis of the storage is more desirable than one across the width.

One person can handle a storage receiving 40,000 lb of milk per day in a 6-hr day if 90 percent of the milk is in quarts and the storage is conveniently arranged. Many plants use twice as much labor. The total cost of operation of the refrigerated storage which includes the cost of conveyor and labor for filling the cooler, the cost of refrigeration but not the cost of loading out was 9¢ and 6¢ per 100 lb for handling 20,000 and 80,000 lb per day, respectively.

Summary

By integrating dairy-processing equipment properly, it is possible to utilize labor and equipment most efficiently. Although one method of doing an operation may be less expensive on a unit basis, it may be desirable to select the more expensive unit operation because of its effect on other operations. The cost of the operation varies considerably with the size of equipment used and volume handled as illustrated by each piece of equipment.

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NEWS SECTION

Nominations for ASAE Medal Awards

IN ACCORD with the rules governing the award of the John Deere and Cyrus Hall McCormick Gold Medals, the Jury of Awards of the American Society of Agricultural Engineers will receive from members of the Society, up to November 1, nominations of candidates for the 1955 awards of these two medals.

The Jury of Awards desires that members of the Society consider it their duty and obligation to give serious thought to the matter and nominate for either or each of these awards the men they believe to be most worthy of the honor. Each nomination must be accompanied by a statement of the reason for nominating a candidate and qualifications of the nominee, including his training, experience, contributions to the field of agriculture, a bibliography of his published writings, and any further information which might be useful to the Jury in its deliberations.

The Jury will consider nominations received on or before November 1, and these nominations should be addressed directly to the Secretary of the Society at St. Joseph, Michigan. The Secretary will supply on request a standard set of instructions for preparing information in support of nominees for the Society's gold medal awards; in fact, it is important that these instructions be followed in preparing material on behalf of any nominee.

New Ohio Section Officers

NEW officers of the Ohio Section of the American Society of Agricultural Engineers, for the year 1954-55, recently announced are as follows: *Chairman,* Robert J. McCall, agricultural engineer, New Way Farm Sales, Columbus; *vice-chairman,* William H. Johnson, assistant professor of agricultural engineering, Ohio Agricultural Experiment Station, Columbus; *secretary,* Dwight F. Warner, instructor in agricultural engineering, Ohio State University, Columbus. The new Nominating Committee of the Section consists of R. C. Miller, T. P. Christen, Jr., and W. R. Schnug.

ASAE Meetings Calendar

August 24-26—NORTH ATLANTIC SECTION, University of Vermont, Burlington

October 14 and 15—PACIFIC NORTHWEST SECTION, Davenport Hotel, Spokane, Wash.

October 23 — MICHIGAN SECTION, Agricultural Engineering Building, Michigan State College, East Lansing

December 6-8 — WINTER MEETING, Edgewater Beach Hotel, Chicago.

February 7-9—SOUTHEAST SECTION, Brown Hotel, Louisville, Ky.

June 12-15, 1955—48TH ANNUAL MEETING, University of Illinois, Urbana

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

New Officers A-E Division of ASEE

THE following officers of the Agricultural Engineering Division of the American Society for Engineering Education, for 1954-55, were recently elected by letter ballot:

Chairman—R. H. Driftmier, head, agricultural engineering department, University of Georgia. Mr. Driftmier also represents the Division on the general council of ASEE.

Vice-chairman—E. W. Schroeder, head, Oklahoma A. and M. College.

Secretary—Frank B. Lanham, secretary, ASAE.

This picture of ASAE members and friends includes most of those who attended the May 17th meeting of the ASAE Chicago Section held at the plant of the A. O. Smith Corporation, Milwaukee

Swink New A-E Head at VPI

EARL T. SWINK has been appointed head of the agricultural engineering department at Virginia Polytechnic Institute, Blacksburg, succeeding Charles E. Seitz, retired. The appointment was officially confirmed July 13.

Mr. Swink received his B.S. degree in agricultural engineering at VPI in 1930 and his M.S. degree in 1939. He is a native of Augusta County, Va., and has been a member of the VPI agricultural engineering department staff since 1935.

From 1930 to 1935 he gained commercial experience, first in the education section of the Westinghouse Electric Corp., and then as district agricultural engineer with the Virginia Electric and Power Co., at Suffolk. While with Westinghouse he earned its "commercial engineer" certificate.

In the department he now heads he has carried progressively increasing responsibility. Starting as assistant extension agricultural engineer and instructor in 1935, he was placed on extension work on a full-time basis in 1940 and given direct charge of the extension project in rural electrification. In 1945 he was promoted to associate extension agricultural engineer and associate professor of agricultural engineering and given added responsibility for the resident teaching work in rural electrification as well as the extension program. He was also called on to collaborate with the research section of the department in planning needed research related to farm electric power applications.

During this time Virginia has become a leader in percentage of farms electrified in the southern states and has achieved a high rank in this respect among all states. Excellent working relationships have been maintained with the commercial utilities, rural electric cooperatives, Rural Electrification Administration, farm organizations and other farm educational agencies.

He contributed actively to the organization of the pioneering Virginia Farm Electrification Council, has served on its executive committee since its organization, and is currently its chairman. He is author of 45 bulletins, leaflets, and circulars on agricultural engineering subjects and of 50 technical papers and popular magazine articles, including one on "Electric Power in Agriculture" for Encyclopedia Brittanica.

In June Mr. Swink completed two years' service as vice-chairman and chairman of the ASAE Rural Electric Division. He is also a member of the American Society for Engineering Education, the National Society of Professional Engineers, and the Virginia Society of Professional Engineers. He is a registered professional agricultural engineer in Virginia. He is married, the father of two sons, a member of the Blacksburg Presbyterian Church, the Christiansburg-Blacksburg Rotary Club, and the Virginia State Grange.

SAE Tractor Meeting

THE national tractor meeting and production forum sponsored annually by the Society of Automotive Engineers and usually held in September will be held September 13 to 16 at the Hotel Schroeder, Milwaukee, Wis. As this issue goes to press, details of the program and other arrangements were not available.

100 Years of Engineering in Agriculture

A FEATURE of its centennial year to be celebrated by Michigan State College in 1955 will be a program on August 16-20 of that year depicting 100 years of engineering in agriculture.

The exhibits, demonstrations and pageants for this celebration will not be limited to Michigan State College, the oldest land-grant college in the country to teach agriculture as a science, but it will be both national and international in scope.

Industry representatives and farm organizations will cooperate with the college and an area of 60 acres on the south campus will be used for exhibits. More than 200,000 people are expected to view the more than 5 million dollars worth of machinery and equipment to be included in this exhibit.

College farm areas will be used for the demonstrations. Historical exhibits, showing 100 years of farm mechanization progress, will be located in the concourses under the football stadium. An arena with grandstand seats for 6,000 visitors will be used for some pageantry and operations.

Pioneers of the agricultural engineering profession will speak on the five-day program and visitors will hear inside stories on the rise of the machine age on the farm. Engineering in the farm home also will be a major part of the program.

Rural Electric Division Steering Committee

THE ASAE Rural Electric Division established its Steering Committee in 1950, and during the past year the Executive Committee and the Steering Committee of the Division, recognizing the need for a systematic plan of rotating Steering Committee membership has developed the following plan: The Steering Committee will consist of 20 members, to include the Division chairman, vice-chairman and junior past-chairman. The Division chairman and vice-chairman will serve in corresponding positions on the Steering Committee.

Tenure of membership on the Steering Committee is to be five years, under which arrangement four members will be added to the Committee each year four will retire.

Under the plan for adding new members, the Committee will submit eight candidates, from which the Executive Committee of the Division will select four nominees to be appointed by the President at the beginning of the new Society year in June.

Each year at the Society's winter meeting in December, the Committee will recommend one of its members, together with an alternate, for appointment as the next Division vice-chairman at the beginning of the new Society year in June.

The Steering Committee will also consider requests for the establishment of other committees within the Division. The chairmen of all committees sponsored by the Division will become ex-officio members of the Steering Committee.

The purpose of the Steering Committee is to serve the interests of the Society in the particular field of rural electrification and its function is briefly as follows: (1) To assist the Division chairman in developing programs for national meetings of the Society, (2) to recommend the establishment of special fact-finding or action committees within the Division, and (3) to recommend nominees for vice-chairman and new Steering Committee members to the President of the Society.

German Ag Engineers Report

Reported by Hans W. Sack
(Assoc. Member ASAE)

AFTER World War II German industry experienced a rather amazing recovery due to some extent to the efforts of German engineers. Incidentally, it is noteworthy that over one dozen German agricultural engineers are members of ASAE.

The 84th annual meeting of the Verein Deutscher Ingenieure (German Society of Engineers) was held at Mannheim, Germany, on May 28 to June 1. Among the many addresses, papers, and other events which featured this meeting, two papers were presented by German agricultural engineers on the program of Max Eyth Gesellschaft (agricultural engineering section of VDI) which was given a full day at the meeting.

Professor Knolle, director of engineering of Heinrich Lanz, AG, Mannheim, presented a paper entitled "The Possibilities and Limitations of Mechanically Handling of Field Work," in which he pointed out the difficulties encountered by agricultural engineers, since there is no clear evidence which way of doing farm work, such as planting, cultivating, harvesting, is absolutely best. Compared to a machine-tool engineer, the farm implement designer has to take into consideration a wide variety of conditions of the materials with which he is concerned.

Going into more detail, Professor Knolle divided the subject of field work into four groups, as follows:

1 Tillage operations. Each specific soil under certain weather and climatic conditions has one particular state which is most favorable to the growth of the scheduled crop. So far no useful method of determining this particular state has been invented. Therefore, century-old tillage methods still prevail.

2 Spreading fertilizer, sowing, spraying. The highest uniformity of distribution is the aim for this kind of work.

3 Harvesting. All harvesting can be reduced to cutting or taking the material out of its immediate surroundings, dividing, sorting out, and transporting. Differences in humidity, inequality in size among the pieces and all the soil conditions for crops grown under the surface are more or less complicated. Limitation in available power on the farm often prevents any combining of two or more processes.

4 Farm power. Due to wide variety of different jobs as well as the bad average utilization, the power source of the farm has to be as versatile as possible.

Professor Knolle did not offer any solutions for the indicated problems. He pointed out the over-all picture of problems in agricultural engineering still unsolved. He maintained that there will not be any great innovation. All the elements for modern farm machines are known and it is more or less a question of useful combination and economical production of those elements.

The second speaker, Professor Rheinwald for the Landwirtschaftlichen Hochschule (agricultural university), Hohenheim, discussed the subject "Mechanization of Farm Yard Work." Professor Rheinwald stated that 60 to 70 percent of all farm work is done in the farm yard. He has investigated which kinds of work could be mechanized. On many farms field work is mechanized but nothing has been done for the yard. The reason for neglecting the yard work is that the labor requirement peaks according to seasonal jobs are more felt by the farmer than the regular everyday yard work. Besides this, it is often difficult and requires a high investment to obtain yard equipment which has to be made to fit into existing barns, silos, and other buildings.

Professor Rheinwald also pointed out that the mechanization of yard work does not result in higher yields as the mechanization of field work so often does. By far the biggest part of yard work consists of transports. A farmer's wife moves 2,500 lb every day. Rationalizing yard work is not necessarily done with the purchase and installation of machines; it is a matter of organization.

Both papers, which aroused considerable interest and also applause, emphasized the importance of cooperation between engineers and farmers.

Steyr Tractors — A Correction

TO THE EDITOR:

IN THE April, 1954, issue of AGRICULTURAL ENGINEERING appears an article giving data on the Steyr tractors, and since a number of points deviate from the facts we take the liberty to correct these points as follows:

1 The Steyr two-cylinder tractor has originally been delivered with 26-hp clutch capacity and the test, which was taken at the government test station in Sweden has been contacted with this model, whereby the stated 25.3 hp were the output on the belt pulley. Here it is usual to give in comparison the output at the clutch.

Since over three years, however, the two-cylinder tractor has been delivered with 30-hp output at the clutch and 28.5-hp output at the belt pulley. The two-cylinder tractors applied so far have now been replaced by a new one, which, however, has the same engines, but which shows several other improvements.

2 At the single-cylinder tractor the wheel track at standard and oilpurpose models is 49.2—57.1 in and at a narrow-track model 33.4—44.9 in.

Regarding the two-cylinder and four-cylinder tractor types, it has been stated that mounting of implements, especially of manure loaders, in front would be difficult. In fact, for both tractor types front-loading implements are being built.

3 Furthermore, in the article it says that the hydraulic lift is only available for the single-cylinder tractor. The fact is that the same hydraulic lift is available for one and two-cylinder models.

In Table 5 for tractor type 280 the speed of the engine is given as 1600 rpm while actually it is 1650 rpm. At the same time the power take-off speed is 540 rpm.

The mower drive in Europe is in most cases constructed for speeds of 6 to 7 km per hr for medium-cut mower bars.

In order to have clean work the stroke must be at least 8 per m, whereby of course higher mower bar rpm are resulting as usual in the United States.

The comparative high weight of the single-cylinder tractors results from the request to use also this tractor with a smaller power output in different agricultural and transport work, especially in mountainous countries as usual in Austria.

The percentage of road transport in Austria or on the continent in general is much higher than in America.

It strikes us that Table 29 shows our new tractor type 180, which is nowhere else even mentioned.

We hope we have given you a clear picture and we would appreciate it if you would issue a correction in one of your early issues.

STEYR-DAIMLER-PUCH
Vienna, Austria

Typical pallet shipment of Torrington Needle Rollers showing two boxes of 20 cans each strapped to pallet. Open box of cans in foreground.

Torrington Needle Rollers—Vacuum-Packed for Cleanliness—Palletized for Easy Handling

Torrington Needle Rollers by the millions are now being vacuum-packed in tin cans to protect them from dirt, moisture and damage. The foods you eat are not packed with greater care.

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To make shipping and handling easier, we pack these cans 20 to a carton and strap two cartons to an expendable wooden pallet, for a total weight of about 1500 lbs. per pallet. This makes an easy load for your fork lift trucks to handle and store.

Torrington Needle Rollers deserve this special vacuum pack. They're precision rollers made under statistical quality controls of extraordinary rigor. Every step from alloy selection to polishing and packing is carefully checked to assure you that every can of rollers you receive meets your high standards. And to help you use these rollers to best advantage, Torrington's engineering staff is always available to assist in application design and testing.

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NEWS OF ASAE MEMBERS

Claude Kedzie Shedd, Fellow and Life Member of the ASAE for many years, retired May 31 after 24 years of service with the U. S. Department of Agriculture. For that period he was actively engaged in research work in connection with farm machinery, farm buildings, and soil conservation

Claude K. Shedd

During the past several years, Mr. Shedd's principal work has applied to grain storage and drying. He supervised cooperative experimental work on these subjects at Urbana, Ill., Lafayette, Ind. Athens, Ga., and Beeville, Tex., as a part of the overall research program conducted on farm buildings by USDA and cooperating agencies.

Mr. Shedd gained widespread recognition for his work in developing an apparatus and measuring rates of airflow through grain and seeds. This work is of particular value in connection with grain drying. His work on grain storage and drying began in 1943, when he became a member of the engineering staff of the Farm Buildings Section of the Agricultural Engineering Research Branch, USDA Between 1930 and 1944, Mr. Shedd was engaged in research work on soil conservation and farm machinery.

A native of Nebraska, Mr. Shedd received a B.S. degree in agriculture at the University of Nebraska in 1909 and a B.S. degree in agricultural engineering from Iowa State College in 1914. He was instructor in agricultural engineering at the University of Nebraska from 1909 to 1911, and from 1911 to 1919 he was assistant and associate professor in agricultural engineering at Iowa State College.

From July, 1919, to September, 1920, Mr. Shedd was in charge of tractor tests which he arranged and conducted at the University of Nebraska. Following this work he was employed by commercial firms as tractor manager and salesman for more than 5 years.

In 1925, Mr. Shedd joined the Kansas Agricultural College staff as extension agricultural engineer in charge of soil erosion, drainage, irrigation and farm machinery projects. Most of his time during this period was devoted to soil erosion studies and he also instructed farmers in surveying in preparation for terracing their croplands. From September, 1928, to March 1930, Mr. Shedd was a staff member of the University of Missouri, where, as extension agricultural engineer, he engaged in much the same pursuits as at Kansas State College.

In March, 1930, he entered permanent employment as agricultural engineer in charge of the soil erosion research setup at Bethany, Mo., He left Missouri in 1931 to conduct studies on corn production at Ames, Iowa.

Mr. Shedd is the author and co-author of many government publications on grain storage and drying, and has contributed many articles on tillage, soil erosion, and grain storage and drying, covering wheat, other small grains and corn, to AGRICULTURAL ENGINEERING and other scientific publications.

Claude Shedd joined ASAE in 1909, and in addition to being active on many committees and contributing to many of its meeting programs, he served as Secretary of the Society for two years, 1916 and 1917.

Mr. Shedd resides with his wife in Denver, Colo., near his son, Robert. Two daughters, Adella Hull and Esther Polito, live in Cleveland, Ohio and St. Louis, Mo., respectively.

Amin Aly Ibrahim, who a few years ago completed requirements and was awarded a PhD degree in agricultural engineering by Iowa State College and who has since been in charge of agricultural engineering work at the College of Agriculture at Chatby, Alexandria, Egypt, was recently awarded a post-doctoral fellowship in agricultural engineering at Purdue University for one year.

Ervin J. Laurion, recently resigned as production and design engineer of the French & Hecht Division, Kelsey-Hays Wheel Co., to accept similar employment with the Saginaw Steering Gear Division of General Motors Corp. at Sagniaw, Mich.

Lowell A. F. Johnson, who has been engaged in farm products research and promotion work for Rilco Laminated Products, Inc., has resigned to accept appointment with the St. Cloud Technical School, St. Cloud, Minn.

Jesse L. Ward, who has been employed as agricultural engineer with the Soil Conservation Service, U. S. Department of Agriculture, has resigned to accept a position in farm electrification work with the Texas Electric Service Co., Fort Worth, Tex.

C. W. Saldeen has resigned as experimental engineer with The Oliver Corp. at its Battle Creek, Mich., works, to accept employment as project engineer with the Tractor and Implement Division of Ford Motor Co., at Birmingham, Mich.

F. Austin Colony, who is associated with the Kay Eliason organization, has reported a change of address from Iowa City to Jefferson, Iowa, and a change from farm drainage to the construction end of the business.

John T. McAlister, who for several years has served as zone engineer of the Soil Conservation Service, U.S. Department of Agriculture, at Spartanburg, S. C., has, with the abolishment of regional offices of SCS, been transferred to Orangeburg, S. C., where his new assignment is that of conservation equipment engineer in a territory covering the upper coastal plain of Georgia and South Carolina.

Cernyw K. Kline has resigned as a member of the agricultural engineering staff of Ohio State University to go into business with his brother and father at Mendon, Mich. The business includes the retail sale of farm-operating equipment as well as general agricultural engineering service, including irrigation and crop drying.

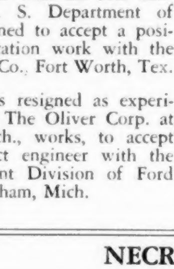
Lawrence A. Donoghue recently completing his graduate work for the MSA degree at Ontario Agricultural College, where he has also been employed as a graduate assistant in the farm structures division of the agricultural engineering department, has taken over the duties of instructor and field man with the agricultural engineering department at the Kemptville Agricultural School, Kemptville, Ont.

William E. Splinter has joined the agricultural engineering department at North Carolina State College as research associate professor. He will devote full time to research in tobacco mechanization with emphasis on the harvesting aspects.

Irvin R. Fisher has resigned as agricultural engineer of the Clay Equipment Corp., to accept the position of development manager of the farm products division of Thermoid Co., manufacturers of automotive, industrial, oil field and textile products, Trenton, N. J. *(Continued on page 584)*

NECROLOGY

Charles N. Stone, former vice-president and director of Deere & Co., passed away at his home in Moline, Ill., July 11. He had not been in good health for some time and his passing was hastened by the sudden death of Mrs. Stone on June 19.



Charles N. Stone

A native of Minnesota, Mr. Stone entered the employ of Deere & Co. at the John Deere Plow Works in Moline immediately on his graduation from the mechanical engineering curriculum at the University of Illinois in 1904. After pioneering many modern factory methods at that plant, he joined the newly-formed John Deere Harvester Works in 1911. In the years from 1912-19 he was manager of the John Deere factory at Welland, Ont., but returned to the Deere Harvester Works in 1920, of which he was made general manager in 1923.

In 1926 Mr. Stone was elected a director of Deere & Co., and in 1934 he was made vice-president in charge of tractor, harvester, and Canadian production. At his own request, he was relieved of his executive duties in 1952, although he continued with the company in a consulting capacity.

Mr. Stone's contributions to engineering developments in the farm equipment field was recognized by the American Society of Agricultural Engineers in 1951 when he was awarded the John Deere Gold Medal. In connection with this award he was commended as "one of the most fully informed men in the industry . . . known not only for the breadth of his learning and experience, but for the breadth of his outlook."

The measure of respect in which Mr. Stone was held by his associates at Deere is reflected in the statement of Burton F. Peek, chairman of the board of Deere & Co., who stated "He discharged the duties of all his positions with the utmost zeal, loyalty, and ability." Company President Charles Deere Wiman said, "Mr. Stone contributed immeasurably to the growth and development of Deere & Co."

Mr. Stone is survived by a brother, Albert J. Stone, and two sisters, Mrs. Edith Stone Adams and Miss Mary E. Stone, all of Quincy, Ill.

NEWS OF ASAE MEMBERS

(Continued from page 582)

Cecil W. Chapman has been selected by the U.S. Soil Conservation Service as state conservationist for Georgia. Prior to this appointment he has for some time been serving as deputy state conservationist.

Robert L. Green has resigned as assistant professor of agricultural engineering at Louisiana State University to accept the position of station superintendent of the Southeastern Tide Water Experiment Station at Fleming, Ga. The station is a federally financed project of the USDA Agricultural Research Service and is cooperative with the Georgia Agricultural Experiment Stations.

Alton G. Levorson, who recently completed an assignment with the FOA mission to Turkey, is now employed as agricultural engineer in the sales department of the Chisholm-Ryder Co., Niagara Falls, N. Y., manufacturers of equipment for canning and of harvesters for crops to be canned.

Blaine F. Parker has been appointed assistant professor of agricultural engineering at North Carolina State College, Raleigh. He received his B.S. and M.S. degrees in agricultural engineering from Virginia Polytechnic Institute and his Ph.D. degree from Michigan State College last month.

Henry D. Bowen, who last month received his Ph.D. degree in agricultural engineering from Michigan State College, has been associated with the agricultural engineering department of North Carolina State College since January 1, 1953, as assistant professor in charge of the teaching program in farm power and machinery.

C. L. Hamilton, who for exactly 10 years served as agricultural engineer and assistant director, farm division, National Safety Council, Chicago, resigned June 1 to accept appointment as a consultant on soil conservation and erosion control to the Bureau of Yards and Docks of the U.S. Department of the Navy.

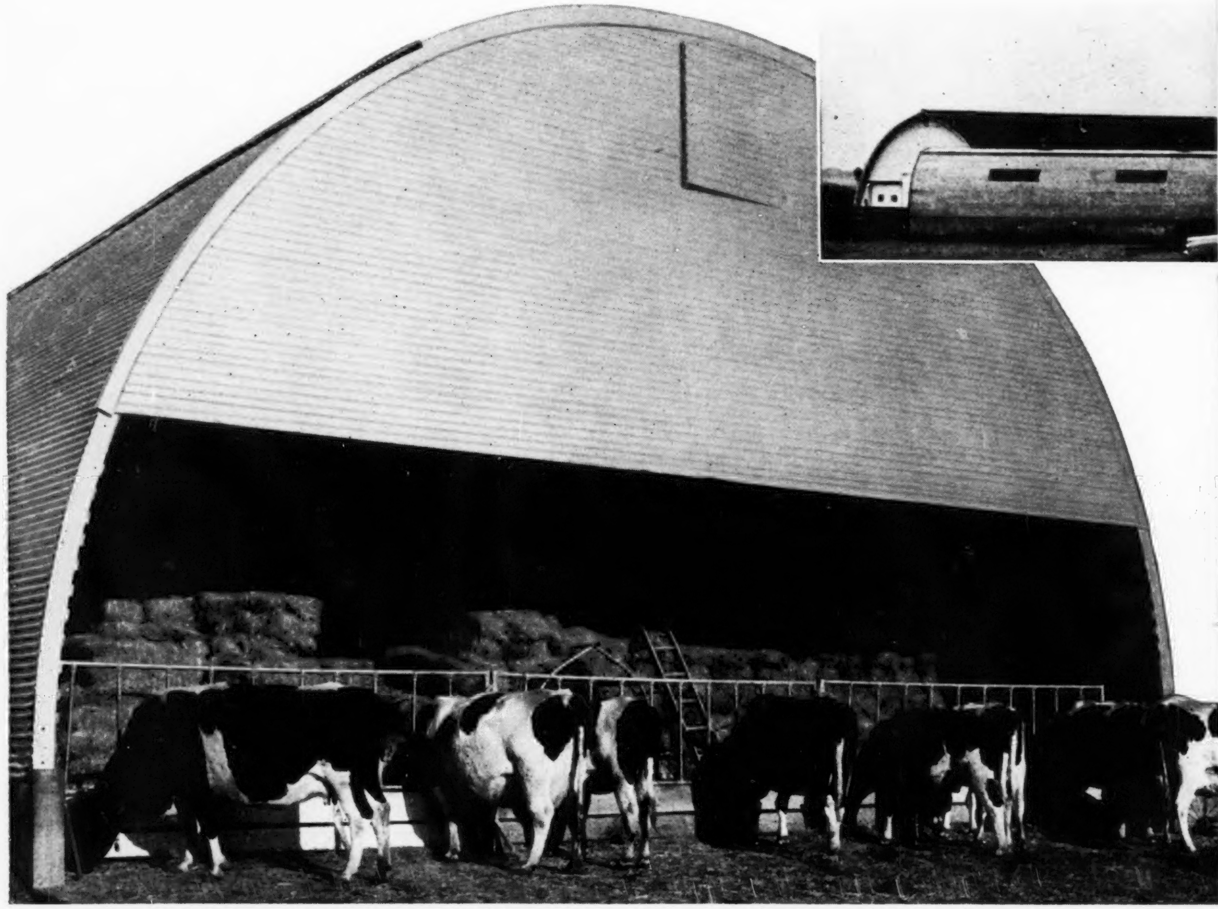
C. B. Richey, formerly holding the position of harvester engineer, is now supervisor of the research section, general engineering department, Tractor and Implement Division, Ford Motor Co., Birmingham, Michigan.

Earl G. Johnson, who has been serving as drainage engineering advisor to TCA in connection with the USA operations mission to Egypt, has completed his work in that country and will return to his former position as zone conservationist, Soil Conservation Service, U.S. Department of Agriculture, at Milwaukee, Wis.

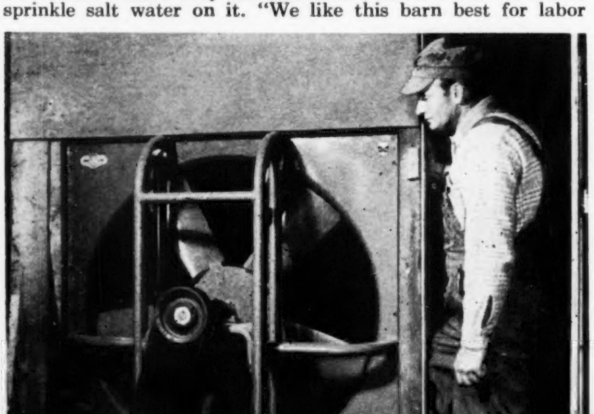
Charles T. Hendrickson, who has been employed at the Battle Creek (Mich.) Works of The Oliver Corp., recently resigned to accept employment in the sales department of the U.S. Gypsum Co.

Howard K. Johnson, who has been employed as an instructor in the agricultural engineering department, Purdue University, is now a research engineer of Cargill, Inc., Minneapolis, Minn.

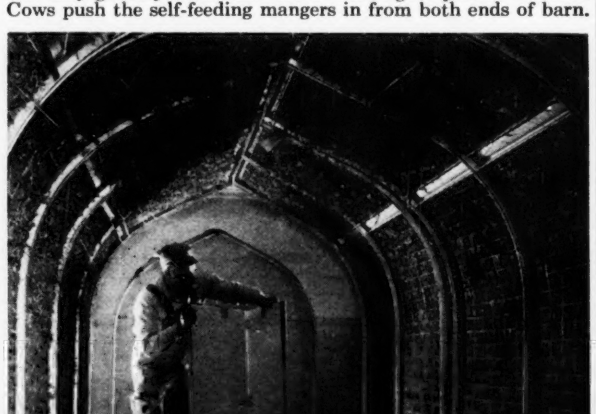
Leonard M. Bumm has resigned as a photogrammetric engineer trainee with Aero Service Corp. to accept employment with the Railroad Perishable Inspection Agency at Detroit, Mich., and will work as a fruit and produce inspector for that organization.



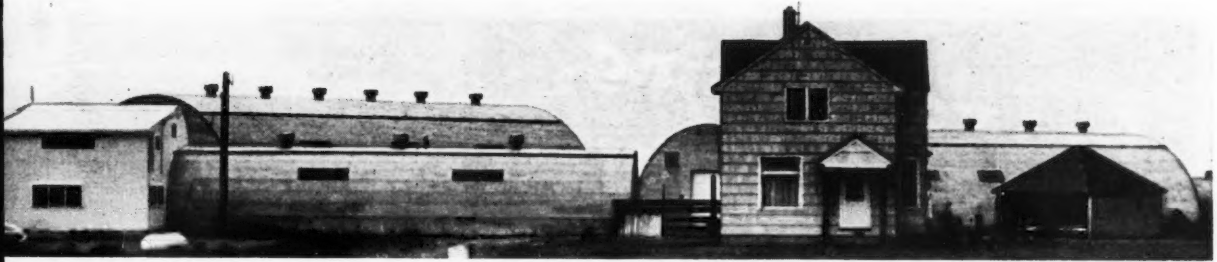
As an experiment, half the 320 tons of hay put in this barn in 1953 was chopped, half baled, but the cows wasted more of the baled this winter. They also eat more when Joe and his father sprinkle salt water on it. "We like this barn best for labor it saves us," they say, and it frees them from worry about bad weather (they dry hay inside after a few hours of field curing) and they get hay with more leaves and higher protein content. Cows push the self-feeding mangers in from both ends of barn.



Joe Kargel looks at the 42-inch fan and 10-horsepower motor at the side of the barn. The fan blows drying, cooling air into an air chamber in the middle of the barn, and tunnels in center of both ends of barn carry this air to all the hay in the barn. Tunnel sections are removed as cows eat their way into the hay.



Joe folds up gate which controls flow of air in tunnel. Gate can be locked in any of tunnel's arches, making it possible to dry hay at any spot in barn. Lateral ducts on floor (opening at lower right) carry air to sides of barn and are spaced to insure complete circulation through all the hay stored in barn.



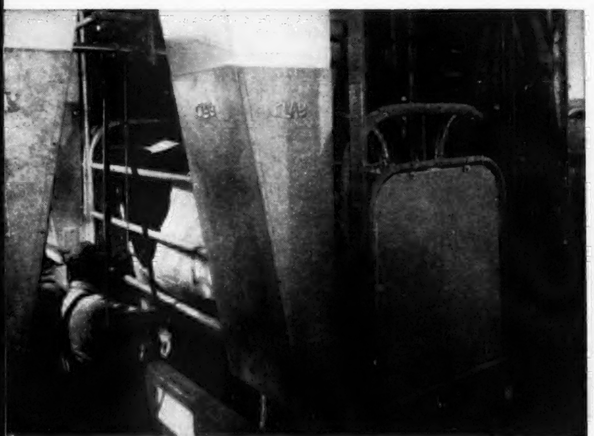
Even the farmstead arrangement is efficient on the Kargel farm. The house is convenient but not too close to other buildings. Everything is built on a knoll with good drainage, and barns are located to give livestock the most protection from winds. There are 55 acres of pasture and hay-grain-corn rotation is used on the rest, with grain following three years of alfalfa.

The Best Way to Handle Hay

A new way to handle hay revolutionized this Minnesota farm. Any ideas here you can use?

If you're looking for little labor and lots of efficiency on a dairy farm, visit Joe Kargel and his father at Lake Elmo, Minnesota. They farm 250 acres, milk 28 cows, have no hired help and plan to increase their milking herd to 75 cows by the end of next year. The buildings and cows do most of the work on this farm and Joe and his father do the planning. You get your first idea of how efficient the operation is when you look at their Quonset 40 by 100 hay drying and storage barn, with self-feeding mangers at each end and the cows feeding themselves. Alongside this is a Quonset 32 by 132 loose-housing barn where the cows find shelter when they're not eating. It's only a few steps from one end of this barn to a Quonset 20 by 156. The closest end of this is a holding area leading to a big 8-cow pit milking parlor with feed bins overhead and a milk house at one side. An 8-foot vestibule separates all this from a calf barn and lets the cows out of the milking parlor. And it all started because the Kargels wanted a better way to handle hay.

There's a Quonset® for Every Job on your Farmstead



Two men put a cow a minute through this 8-cow milking parlor. Dial settings on feed chutes give each cow the right amount of feed in bowl, there's hot and cold water in each pit, the men raise and lower gates at a touch and sloping concrete walls on stalls give cows minimum foot room, makes them all stand still.

These cans will be replaced by a bulk cooler just as soon as a bulk route is established in the Kargel neighborhood. Two big windows at Joe's left give complete view of the milking parlor. Joe's oldest son (he has four) is only 12, but the work is so easy in this milking parlor that he frequently mans one pit.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Andersen, Bob R.—Owner, Evergreen Builders, 1382 Smith Rd., Bellingham, Wash.

Bloodworth, Joseph C.—Assistant chief of program development branch, U.S. Army, Corps of Engineers. (Mail) Apt. 29, 115 Crestwood Dr., Daly City, Calif.

Boyd, Morton, M.—6 Lynton Lane, Ben Avon Heights, Pittsburgh 6, Pa.

Chatelain, Paul E. — 2nd Lt., USAF. (Mail) 2022 Cambrome St., New Orleans, La.

Cox, Stanley L.—Engineer, General Electric Co. (Mail) 876 Highland Ave., South Portland, Me.

Disselkamp, Donald E.—Trainee, Caterpillar Tractor Co. (Mail) RR 1, Morris, Minn.

Fleharty, Gerald—Engineer, Dempster Mill Mfg. Co., Beatrice, Nebr. (Mail) 612 N. Fourth.

Henry, Samuel F. — Rural representative, Pennsylvania Power Co. (Mail) RR 3, Slippery Rock, Pa.

Holt, Duncan E.--District manager, International Harvester Co., 580 Whitehall St., SW, Atlanta 2, Ga.

Lewis, Thomas P.—Building inspector, Cotton States Mutual Insurance Co. (Mail) RR 3, Box 137, Fitzgerald, Ga.

Lindsay, George G.—Lecturer in agricultural engineering, Canterbury Agricultural College, Christchurch, New Zealand (Mail) Lincoln College

Mann, John F.—Engineering trainee, General Electric Co., Ft. Wayne, Ind. (Mail) 2021½ S. Harrison St.

Martin, Keith B.—Engineer, Yallahs Valley Land Authority, 58 Brentford Rd., Cross Roads, Jamaica, British West Indies

Milligan, James S. — Engineering trainee, Schlumberger Well Surveying Corp., Electra, Tex. (Mail) 308 W. Michigan

Noonan, Francis D.—Agricultural engineer, Bureau of Indian Affairs, (USDI) (Mail) Frankfort, S. D.

Patil, Uttamrao A.—Consulting engineer, 205 Virginia Ave., Rochester, Pa.

Perry, Thomas A.—Partner George A. Perry and Son, Arlington, S. D.

Schwanz, H. Lee—Associate editor, *Country Gentleman*, Independence Square, Philadelphia 5, Pa.

Seath, Donald D.—Production trainee, Ralston Purina Co. (Mail) 123½ Waldron, W. Lafayette, Ind.

Smith, Homer K.—Student, University of Tennessee (Mail) 3805 Bristol Hwy., Kingsport, Tenn.

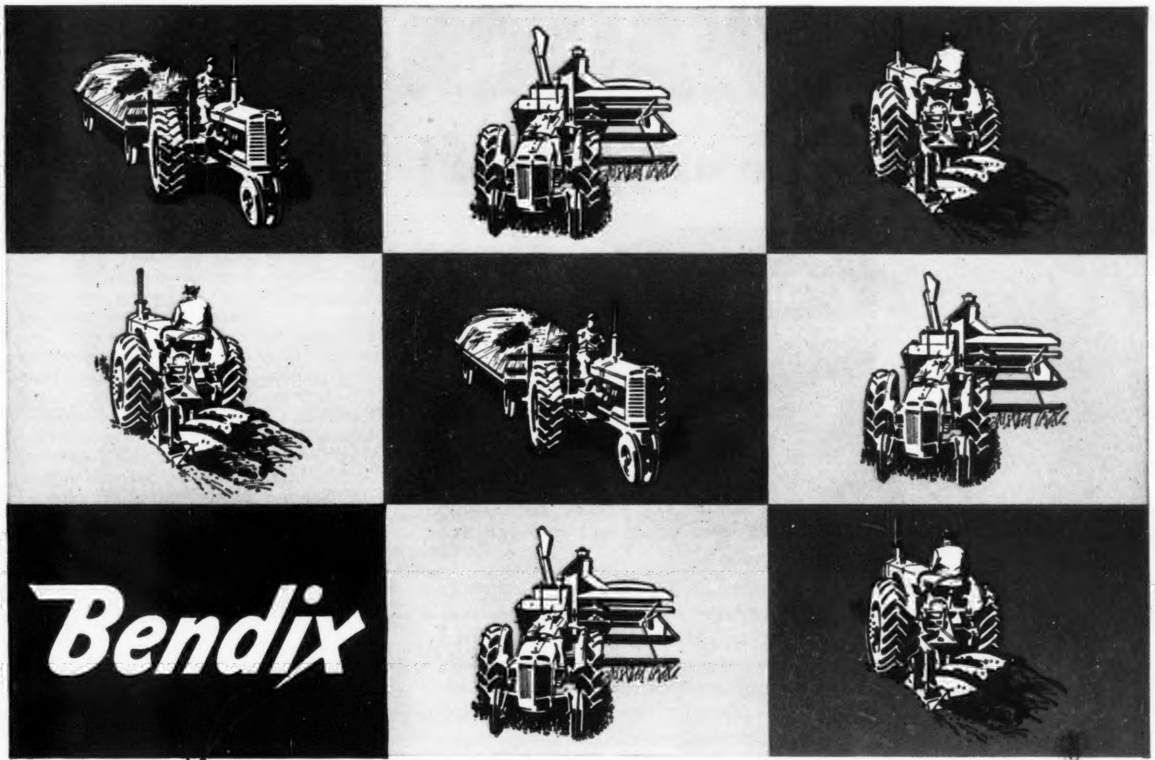
Swihart, Maurice L.—Rural representative, Indiana & Michigan Electric Co., Ft. Wayne, Ind. (Mail) 2414 S. Wayne Ave.

Transfer of Membership Grade

Hotchkiss, K. W.—Co-owner, Hotchkiss & Rietveld, Clarks Grove, Minn. (Associate Member to Member)

Rooney, Robert P.—District agricultural engineer, N.Y. State College of Agriculture. (Mail) Main St., Wyoming, N. Y. (Affiliate to Associate Member)

Schleusener, Paul E.—Assistant professor in agricultural engineering, University of Nebraska, Lincoln, Nebr. (Associate Member to Member)


Bendix

NEW BOOKS

Supplemental Irrigation for Eastern United States, by Harry Rubey. Cloth, 209 pages, 5½ x 8 inches. Illustrated and indexed. Interstate Printers and Publishers (Danville, Ill.) $3.50.

This is a practical guide designed to be a help to farmers, agricultural extension workers, and technical advisers in its field, written so that it may be understood by persons with little previous knowledge of the subject. Chapters cover Introduction, Favorable Conditions Necessary, Sources and Conveyance of Water Supply, Methods of Applying Water to the Land, Surface Irrigation, Irrigation by Sprinkling, Water Requirements, Water and Fertilizer Team Up for Better Yields, Costs and Profits, and Conclusions. Appendixes present information on How to Go About Starting Irrigation, Glossary, Pumping, Sprinkler Systems, Surface Leveling Systems, Surface Distribution Systems, and Selected and Annotated References.

Heating, Ventilating and Air Conditioning Guide, 1954 (32nd edition). Cloth, xxiv + 1616 pages, 6 x 9 inches. Illustrated and indexed. American Society of Heating and Ventilating Engineers (62 Worth St., New York 13, N. Y.) $10.00.

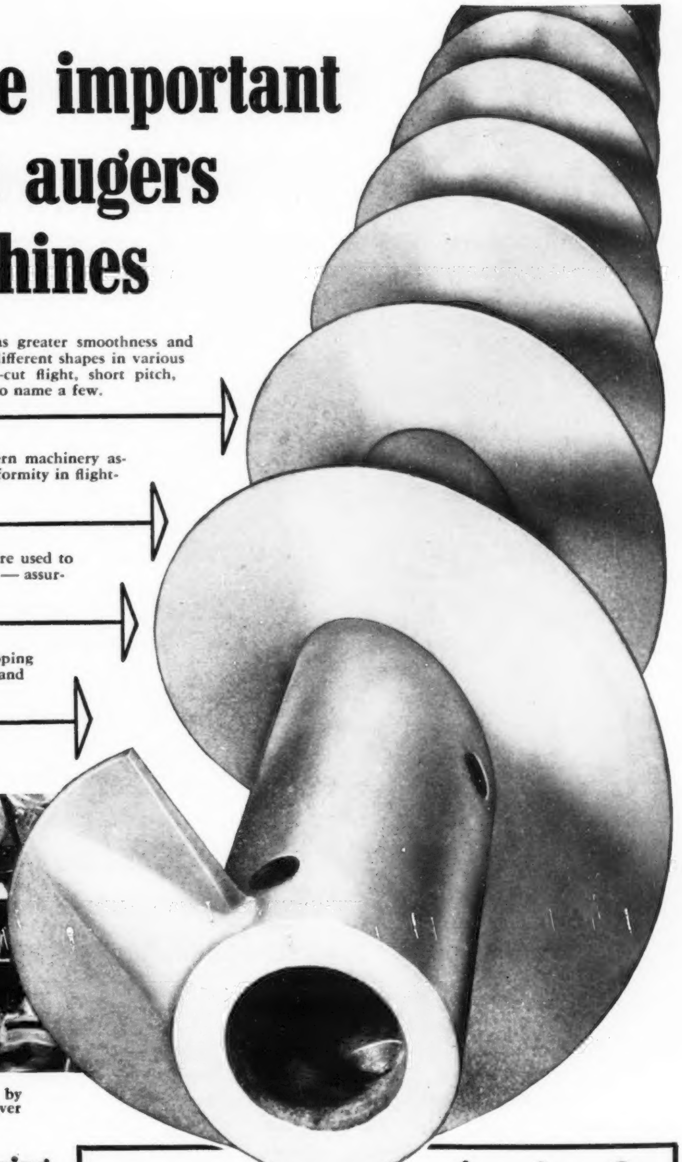
Technical and manufacturers catalog data sections. Subsection and chapter headings and arrangement in the technical data section are substantially the same as for last year's edition. The Technical Data Section has been increased by 32 pages to a total of 1128 pages—the largest to date. The Manufacturers' Catalog Data Section has also been enlarged to 486 pages. New features of this volume include a chapter on "Residential Summer Air Conditioning." New information has also been added on methods of obtaining local relief in hot, humid environments, air and gas cleaning, steam requirements of process equipment, and characteristics of pipe and tubing.

Chapters brought up to date by major changes include those on heating load, fuels and combustion, chimneys and draft calculations, panel heating, pipe, fittings, weldings, district heating, air cleaning, automatic controls, electric heating, and owning and operating costs. The 51 chapters of The Guide are grouped in seven sections and include such topics as: Fundamentals, Human Reactions, Heating and Cooling Loads, Combustion and Consumption of Fuels, Systems and Equipment, Special Systems, and Instruments and Codes. The ASHVE Psychrometric Chart is included separately in large size, 24 x 32 in, and is printed in two colors to facilitate the solution of problems involving air.

The Economic Almanac 1953-54, of the National Industrial Conference Board. Twelfth edition. Cloth xii+740 pages, 5½ x 8 inches. Thomas Y. Crowell Co., (432 Fourth Ave., New York 16, N. Y.) $3.95.

Tabulated data on Population, Resources, Agriculture, Prices, Banking and Finance, Public and Private Debt, Communications, Transportation, Trade, Electricity and Gas, Construction, Service, Mining, Manufacturing, American Enterprise—General, Statistics of Individual Industries, The Labor Force, Consumption and the Standard of Living, Individual Savings and National Wealth, National Income, Public Finance, United States Foreign Trade, International Financial Position of the United States, and International Economic Statistics.

CHECK these important differences in augers for farm machines

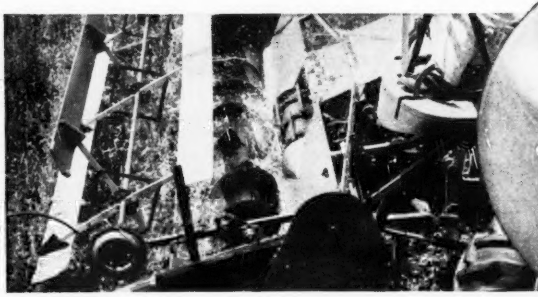


✓ **ONE-PIECE HELICOID FLIGHTING** has greater smoothness and strength. Link-Belt also builds many different shapes in various metals to meet your specific needs—cut flight, short pitch, ribbon flight, tapering, double flight to name a few.

✓ **UNIFORM PITCH** — Specialized modern machinery assures accurate forming, producing uniformity in flighting curvature.

✓ **ONLY SPECIALLY SELECTED STEELS** are used to meet Link-Belt's rigid specifications — assuring smooth flight surfaces.

✓ **STRAIGHTNESS** is checked before shipping and extra care is taken in handling and loading.



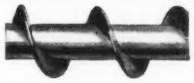
Complete auger for this harvester-thresher is furnished by Link-Belt. Opposed flights move cut grain to center, deliver it to pick-up conveyor.

LINK-BELT gives you sound engineering plus accuracy of manufacture for top performance

WHEN you make a Link-Belt auger part of your farm machine, you can be sure of efficient operation plus long-life, low-maintenance service. Link-Belt builds augers for every purpose—gathering cut grain back of the sickle bar, conveying, elevating, spreading, feeding, mixing or digging.

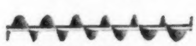
Each can be engineered for your specific requirements . . . each will provide long-lasting efficiency, thanks to Link-Belt's unequalled accuracy of manufacture. Let your nearby Link-Belt sales representative point out the many important differences in augers to you. And be sure he gives you a copy of Book 2289, covering Link-Belt's regular line of conveyor screws and components.

Typical examples of Link-Belt Augers



Sectional-flight

Helicoid flight with end, plain beater



Helicoid flight auger

Opposed flights with center saw-tooth beater

Unmounted Helicoid flighting

LINK-BELT

THE SYMBOL OF QUALITY LB LINK-BELT

FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N. S. W.; South Africa, Springs. Representatives Throughout the World.

13,384

NEW BULLETINS

Fertilizing Through Irrigation Water, by John R. Davis and R. L. Cook. Michigan State College (East Lansing), Extension Bulletin 324 (June, 1954). A 23-page bulletin describing fertilizer and equipment aspects of applying plant nutrients through irrigation waters. Primary attention is focused on fertilizing through sprinkler irrigation systems. The bulletin covers fertilizers suited for application, methods of applying the fertilizer, quantities to apply, practical hints for the farmer, mixing and storing fertilizers, and information on applying insecticides and fungicides through irrigation water.

An Instrument for Recording Shaft Speeds, by O. J. J. Rogers and D. W. Tanner. Technical Memorandum No. 101 (March, 1954) National Institute of Agricultural Engineering (Wrest Park, Silsoe, Bedfordshire, England). This describes means by which Kelvin and Hughes strain-recording equipment can be used to record voltage rather than impedance changes and in conjunction with an electrical tachometer, to record shaft speeds.

Tobacco Priming Studies, by C. W. Suggs and R. W. Wilson. North Carolina Agricultural Experiment Station (Raleigh), Agricultural Engineering Information Circular No. 9 (April, 1954). Reports results of studies designed to experimentally determine benefits of priming tobacco riding versus the conventional walking method now used. Fatigue (measured by increase in heartbeat rate), speed, quality, and operator preference results were secured from the various treatments. The results showed riding to be highly beneficial in the amount of energy saved over walking.

Loose Housing for Dairy Cattle, by Thayer Cleaver and Robert G. Yeck. Agricultural Information Bulletin No. 98, U.S. Department of Agriculture (Washington, D.C.). Recommends layout, construction features, and related operating practices which meet requirements for Grade A milk in most areas.

NIAE Bulletins. The following bulletins have been received recently from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England.

Report on Test of the "Holt" Straw Deflector—No. 86.

Ventilation and the Supply of Carbon Dioxide to a Glasshouse Tomato Crop—Technical Memorandum No. 87.

Testing a Spray Deposit Analyser—Technical Memorandum No. 100.

Agricultural and Horticultural Engineering Abstracts, Vol. 5, 1954, No. 1.

Effectiveness of Nails versus Staples for Fastening Underlayment, by E. Geo. Stern, Virginia Polytechnic Institute (Blacksburg) Wood Research Laboratory Bulletin No. 13 (February, 1954). Reports in 8 pages of text, tables and illustrations results in holding power favorable to ringed-shank nails, over either smooth-shanked nails or staples.

Experiments in Harvesting and Preserving Alfalfa for Dairy Cattle Feed, by J. B. Shepherd et al. Technical Bulletin No. 1079 (February, 1954) U.S. Department of Agriculture, Washington 25, D.C. (Superintendent of Documents, 45 cents.) Reports results favorable to dried hay and wilted silage over field cured hay, in terms of relative milk production. *(Continued on page 594)*

NEW BULLETINS

(Continued from page 592)

The Effect of Solar Radiation on Measurements of Glasshouse Air Temperature, by L .G. Morris and K. W. Winspear, National Institute of Agricultural Engineering (Wrest Park, Silsoe, Bedfordshire, England) Technical Memorandum No. 102 (May, 1954). Measurements with typical thermometer installations compared with those of aspirated thermocouples and the Assman psychrometer, to show errors in thermometer readings, with observed errors running up to 20 F.

A Survey of In-Bin Drying Plants in Scotland, 1952, by G. G. Corbett and A. Veitch. Scottish Machinery Testing Station (Howden, Mid Calder, Midlothian, Scotland) Technical Memorandum No. 103 (March, 1954). Reports on descriptions of plants, weather during harvest and drying season, plant performance, grain deterioration and plant management.

Making Durable Concrete Drain Tile on Packer-Head Machines, by Philip W. Manson and Dalton G. Miller. Minnesota Agricultural Experiment Station (University Farm, St. Paul) Bulletin 426 (May, 1954). Practice recommendations based on research and covering aggregates and cement, maximum mixing water, compaction of materials, tile curing, special soil considerations, and conclusions, with an appendix on bedding and allowable depths.

Lessons in Farm Electrification, by E. F. Olver, R. N. Jones, D. R. McClay, and F. Anthony. Pennsylvania State University, College of Agriculture (State College) Miscellaneous Publication No. 2 (August, 1954). A demonstration guide prepared as a help to vo-ag teachers, 4-H workers, power suppliers, and other extension personnel, with lessons on principles of polarized circuits, measuring electricity, wire size, motors, heating, lighting, and wiring layouts. Available at 3 for $1.00 in Pennsylvania, 2 for $1.00 elsewhere.

Septic Tanks — Design, Construction, Maintenance, by N. Henry Wooding, Jr., and R. R. Kountz, Pennsylvania State University (State College) Extension Service, Special Circular 17 (June, 1954). Double folded to 8½x11-inch page size, this gives three pages of condensed text on the subject. Unfolded, the reverse side shows drawings and pictures of recommended installations, with tabulated data on capacities, dimensions, and disposal field requirements.

Planning Farm Fencing. Southern Association of Agricultural Engineering and Vocational Agriculture (University of Georgia, Athens, April, 1954). Vocational teaching material edited to junior high school reading level, with chapters on Planning Location and Arrangement of Fences, Determining the Kind of Fence to Use, Determining What Quality Fencing to Buy, Selecting an Electric Fence Controller, Deciding What Kind of End or Corner Construction to Use, Determining the Kind and Number of Line Posts to Use, and Determining Types of Passageways Needed.

Building Farm Fences. Southern Association of Agricultural Engineering and Vocational Agriculture (University of Georgia, Athens, May, 1954). A companion publication to "Planning Farm Fencing," with chapters on Building a Woven Wire Fence, Building a Barbed Wire Fence, Grounding Wire Fences for Lightning Protection, Building a Movable Fence, and Building Board Fences.

Twenty-Ninth Annual Report of the Kansas Committee on the Relation of Electricity to Agriculture (1953). Limited circulation, Department of Agricultural Engineering, Kansas State College (Manhattan). Presents a report of the 29th annual meeting of the Committee, including information presented on a "Rural Electrification Survey" by the Kansas Corporation Commission; "Analysis of Extraction of Heat from Earth by Intermittent Operation of a Ground Coil Heat Exchanger," by Chester P. Davis, Jr.; "A Laboratory Investigation of a Heat Pump Grain Drier," by Ralph Lipper; "Heat Pump Water Heater Operational Tests," by Chester P. Davis, Jr.; "Electricity in Wheat Storage," by F. C. Fenton; "Automatic Grinding and Mixing of Ear Corn and Small Grains," by Ralph I. Lipper; "Summary of Evaluation of the Phase Converter-Three-Phase Motor"; Evaluation of the Phase Converter-Three Phase Motor," by John W. Hooper and Kenneth A. Harkness; "The Vocational Agriculture Education Program," by Kenneth Harkness; "Summary of the 4-H Club Farm and Home Electric Leaders Training Conference," by Harold Stover; "The Kansas C. R. E. A.—Its History and Purpose," by F. C. Fenton, Henry M. Turrell, F. M. Kimball, Fred J. Yarrow, Charles Ellis, S. W. Milligan and H. S. Hinrichs.

Nailed Trussed Rafter of 24-ft Span and 3-in-12 Pitch, by E. George Stern. Virginia Polytechnic Institute Wood Research Laboratory (Blacksburg) Bulletin No. 14 (April, 1954). Construction details and test data indicating characteristics.

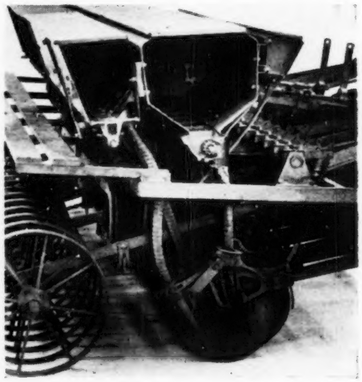
NEW PRODUCTS CATALOGS

Hardenability of Steels

International Nickel Co., 67 Wall St., New York 5, N. Y., will send on request to interested readers a copy of its bulletin A-63 "Some Aspects of the Hardenability of Steels," containing 12 pages documented with charts and photomicrographs. The selection of steels solely on the basis of the usual hardenability tests may be an inadequate procedure especially where optimum performance qualities are essential or desired. Steels with the same end-quench hardness curves or hardenability are shown in this bulletin to have much different toughness as measured by notch-bar tests at equal hardness and strength levels.

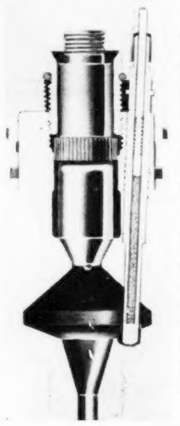
A New Press Grain Drill

International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., announces a new press grain drill, the McCormick K-6, for areas where low rainfall and light, loose soil make soil and water conservation important. It is built in 7, 10, and 12-foot sizes, has 20-in-diameter press wheels that provide a firm pressing action desirable in loose seedbeds. A new arch-type frame makes it possible to equip this drill with regular double-disk furrow openers, or with three different types of single-disk openers. The drill has a strong, rigid welded-steel frame and the



forecarriage wheels are full castoring. It will sow all the grains in a wide range of quantities, and a depth regulator increases the speed and ease of obtaining the exact planting depth required.

Direct Electric Starting for Diesel Tractor



Caterpillar Tractor Company, Peoria, Ill., announces that after years of cooperative research by that company and General Electric Co., it has developed the glow plug, which, acting as a heating element, extends into the precombustion chamber. When activated by battery current, the glow plug reaches a temperature of 1800 deg within 30 sec. The glow plug is part of a direct electric-starting system that provides positive starting of Caterpillar diesel tractors in below freezing weather. About the size of an ordinary pencil, the glow plug is actually a heating element, part of which extends into the combustion chamber of the diesel engine. It is available as original equipment for the Caterpillar D4 track-type tractor.

Corn Picker-Forage Harvester

J. I. Case Co., Racine, Wis., has introduced a new corn harvester which is a combination corn picker and forage harvester. The machines picks the ears and elevates them into a trailing wagon. Stalks and

leaves are cut and chopped or shredded and delivered to a side-drawn wagon for use as feed or bedding, or dropped on the ground. The new harvester can be quickly attached to the base unit of the current Case field forage harvester, the same as the row-crop, field cutter and windrow attachments.

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN — FEBRUARY — O-19-602. MARCH—O-65-603, 66-604, 67-605. APRIL—O-98-614, 106-615, 116-617. MAY—O-149-620, 155-623, 108-624, 162-625, 173-626. JUNE—O-180-627, 181-628, 197-629, 198-630, 182-631. JULY—O-204-633, 205-634, 207-635, 209-636, 208-637, 219-638, 222-639, 214-641, 231-642, 232-643.

POSITIONS WANTED—FEBRUARY—W-46-108. MARCH—W-56-112, 54-113, 37-116. APRIL—W-84-120, 93-123, 109-124, 124-125, 125-126, 107-127. MAY—W-122-128, 146-129, 128-130. JUNE—W-115-131, 164-133, 169-134, 141-135, 179-136, 199-137. JULY—W-177-138, 189-139, 224-141.

NEW POSITIONS OPEN

Agricultural Engineer for research on new developments and trends in agriculture in relation to needs for new machines or modifications of existing machines, with full-line farm equipment manufacturer in Midwest. Age 25-35. BS deg or higher in agricultural or other technical engineering. Farm background and 3 to 6 yr in power and machinery teaching, research, extension, design or farming. Ability to analyze and evaluate new ideas and practices, combined with creative imagination. Must also be able to express ideas orally and in writing and sketching, and able to cooperate with others. Some travel required. Good opportunity for advancement. Salary open. O-242-644

Agricultural Engineer to head product development program on crop driers, aeration systems and related equipment, with established manufacturer in Midwest. Age 25-40. BS deg or higher in agricultural or mechanical engineering. Experience in design, estimating and development work. Able to supervise work of others and report on work done. Opportunity dependent on products developed. Salary — $4800-7200. O-248-645

Agricultural Engineer for product engineering in farm structures field with fabricator of steel products. Midwest location. Age about 25. BS deg in agricultural engineering, or equivalent, with specialization in farm structures. Intelligent, with pleasing personality, ability and desire for design work. No experience required. Prefer man who has completed his active military service obligation. Good starting opportunity in expanding program with a growing company which promotes from within the organization. Salary about $375 per month. O-249-646

Market Specialist (agricultural markets) for promotion of use of various steels, through writing and editing reports and bulletins, research projects, and group contacts, with steel producer in Midwest. Age about 25. BS deg in agricultural engineering or equivalent, with major in farm power and machinery. Intelligent, with pleasing personality and ability to write promotional material on use of steel in agricultural markets. No experience required. Prefer man who has completed his active military service obligation. Excellent opportunity for advancement. Company promotes from within. Salary about $375 per month. O-250-647

Agricultural Engineering research fellowship in rural electrification. Half time research on effect of high frequency radiation of seeds; half-time on work toward MS degree. Research material may be used as basis for thesis. BS deg in agricultural engineering or equivalent, with B average or better and 3 or more courses in electrical field in addition to physics. Usual personal qualifications for work toward advanced degree. Excellent opportunity for qualified man to participate in development of a new field with apparently unlimited possibilities. Should be able to complete requirements for MS deg in two years. Salary, $1800 half-time. O-251-648

Agricultural Engineer for research on farm applications of fabricated metal products, with established manufacturer in Midwest. Age, under 35. BS deg in agricultural engineering or equivalent preferred. Experience in product research, design, and experimental development. High level of initiative, imagination and active interest in applied research. Excellent opportunity for advancement, based on performance. Salary, up to $6500. O-244-649.

NEW POSITIONS WANTED

Agricultural Engineer for sales or manufacturers representative in power and machinery, farm structures, soil and water or construction equipment field with manufacturer or distributor, anywhere in USA. Willing to travel. Speak, read, and write Spanish fluently. Married. Age 31. BS deg in agricultural and mechanical engineering, 1949, California State Polytechnic College. Assistant county civil engineer 13 mo., on dam and reservoir design and construction (earth and concrete) and on erosion and drainage control. With present employer 4 yr on irrigation design, sales of full line of irrigation equipment, report writing, technical evaluation and recommendations, and dealer education. War non-commissioned service in Navy over 3 yr. Available in September. Salary $5400 plus commission and expenses, or equivalent. W-237-142

Agricultural Engineer for design, development or service in power and machinery field, with manufacturer, processor, or distributor. Northeast preferred but will consider other areas. Limited travel. Married. Age 32. BS deg in agriculture, 1947, Rutgers University; BS deg in agricultural engineering 1949, University of Nebraska. Farm background. Student assistant on Nebraska Tractor Tests one year. Agricultural engineer with US Soil Conservation Service 4 yr. Farm products development engineer 9 mo. War non-commissioned service in Army Air Force, 3 yr. Available August 15. Salary $4000 plus. W-252-143

Agricultural Engineer for design, development, or research in irrigation and drainage, with farming operation, any location. Married. Age 31. BS deg, 1941, surveyor deg 1947, Santa Clara, Cuba. Agr. Eng. deg 1950, University of Havana (Cuba). Experience as surveyor, 6 yr. Work on irrigation systems in Cuba, 2 yr. Work on irrigation and drainage systems in Ecuador, 2 yr. Available in December. Salary open. W-265-144

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Index to Advertisers

Personnel Service Bulletin

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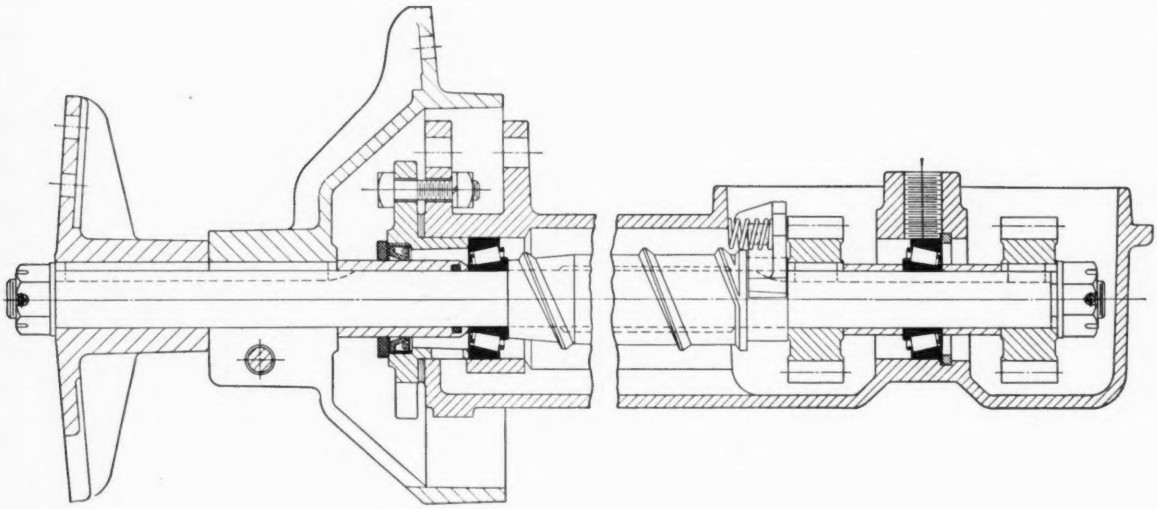
PRODUCT DESIGN ENGINEERS (2) and junior product design engineers (2) for work on harvesting equipment with leading full-line farm machinery manufacturer in Midwest. BS deg in agricultural or mechanical engineering. Design engineers should have 2 to 10 yr experience on either combines, corn pickers, or forage harvesters, and be capable of assuming design responsibility, including following a project through development, field test, and preparation of specifications for production release. For juniors, prefer recent graduates interested in product design or combines, corn pickers, balers, or forage harvesters. Must be aggressive, with initiative to train for responsible design engineer positions. Salary open. O-276-650

Professional Directory

RATES: 80 cents per line per issue; 40 cents per line to ASAE members. Minimum charge, five-line basis. Uniform style setup. Copy must be received by first of month of publication.

How Dempster Holds Windmill Sail Shaft in Alignment, Keeps Gears Meshing Accurately



BY through-boring this sail shaft housing, Dempster assures that shaft and gears are installed in accurate alignment. But in operation, high winds impose heavy thrust loads. Quick shifts in wind direction create sudden radial loads. How to keep the sail shaft in accurate alignment and keep gears meshing accurately was the problem.

Timken® tapered roller bearings proved to be the answer. Because of their tapered design, they take radial loads, thrust loads or *any* combination of the two. Full line contact gives Timken bearings load-carrying capacity to spare. The sail shaft is held in positive alignment. Gears mesh accurately. And heavy loads don't disturb the alignment of either the gears or the shaft.

Exposed as the windmill is to air-borne dust, you'd think that dust particles might get in and cause bearing failures. But Timken bearings make closures more effective because they hold housings and shafts concentric. Dust stays out—lubricant stays in.

Wear is held to a minimum because Timken bearings practically eliminate friction. They can because they're designed to roll true; and because they're made with microscopic accuracy to conform to their design. And you're doubly assured of Timken bearings' quality, because we make our own steel. No other U. S. bearing maker does.

For your free copy of "Tapered Roller Bearing Practice in Current Farm Machinery Applications", write: The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

The farmer's assurance of better design

TIMKEN Tapered Roller BEARING EQUIPPED

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST → ← LOADS OR ANY COMBINATION